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ABSTRACT

This guide is designed to provide teachers with materials they can use with young women to help them to achieve in mathematics and to encourage them to take as many math courses as possible in high school. During their early school years, students develop skills and attitudes toward learning that form the basis of future academic growth. This guide for elementary school teachers includes strategies, activities and resources that deal with five major topics. Part 1, "Attitudes and Math," includes materials on mathematics confidence, math aspirations and expectations, and attribution patterns. Part 2, "Math Relevance," contains materials related to interest in mathematics, making mathematics more relevant and useful, and positive role models for girls. Part 3, "The Learning Environment," contains materials on teacher-student interaction patterns, cooperative learning, problem solving, and independent thinking, intellectual risk taking, and creative problem solving. Other issues are collected in Part 4. Materials on computers, spatial visualization skills, and test-taking skills are included. Part 5 "Mathematics Promotion," includes materials on parent involvement, school counselors, and administrators and other teachers. Each topic in this guide begins with a discussion of research findings on the practices and/or attitudes that affect girls' math attitudes and performance. Strategies, activities, and resources that can be used to address each topic are described. Within each topic, activities for the primary grades are generally listed before those for the intermediate grades. An annotated resource list at the end of each chapter provides resources that contain strategies, activities, and ideas. (CW)

Add-Ventures for Girls: Building Math Confidence

Junior High Teacher's Guide

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Preface

The issue of girls and mathematics is important for all teachers. At the elementary level, girls often enjoy math and attain achievement levels equal to or higher than those of boys; however, by the time they reach high school, many bright girls become disinterested in mathematics, enroll in fewer advanced math classes, achieve lower math scores than boys on college placement tests, and are less likely to choose careers that are highly math-related. Mathematics is an important foundation for many rewarding occupations. In neglecting to develop their math skills, many girls are excluding themselves from a large number of potentially satisfying careers.

The reasons for high school girls' loss of interest and relatively lower achievement in math have been carefully studied by many researchers over the past ten years. No single cause has emerged. Instead, we find an interrelated set of attitudes, self-perceptions, and feelings reinforced by society, parents, teachers, and peers that can combine to produce strong barriers toward girls excelling in math. This book describes those attitudes and the practices that reinforce them; it then provides strategies, activities, and resources that teachers can use to help girls overcome barriers and reach their full potential in mathematics.

When girls enter elementary school, most of them enjoy math and do well in it. During the elementary grades, however, they begin to perceive mathematics as a subject more appropriate for boys and to lose confidence in their own mathematical abilities. By the time they reach the junior high school years, girls have become extremely conscious of sex roles. To be thought "feminine" by one's peers is a key goal. If math has been stereotyped as a "male subject," girls are more likely to avoid it. During junior high and the early high school years, students make important decisions about their futures through their choices of math courses. It is particularly important that junior high teachers recognize the subtle and blatant messages that society gives to girls, and take action to counteract these messages before girls drop out of math.

Although equitable mathematics instruction is a very important subject, it is an area often neglected in teacher education. To fill this gap, many excellent supplementary publications on girls and math have been developed. In this book, we acquaint middle school teachers with areas of concern and then suggest strategies, activities, and resources to use in the classroom to help girls do their best in math. A second book has been prepared for elementary teachers.

To develop this book, we spent several months researching the subject of girls and math. We reviewed countless research studies and many resource books for parents and teachers. After delineating the problem and outlining the topics we wanted to cover in this guide, we invited local elementary, middle, and high school math teachers and administrators to brainstorm with us. These teachers and administrators discussed strategies, activities, and resources they had used in each of the selected topic areas. We incorporated their ideas, concepts from research materials, and our own thoughts into this guide. Two outstanding local teachers, Anne Mills, who teaches math at a junior high school, and Jennifer Salls, who chairs a high school math department, reviewed the book and added their comments and suggestions.

The final product represents the work of many persons. The authors wish to thank the members of our Advisory Committee: Kenneth Johns, Carol Olmstead, Jennifer Salls, Barbara Schlenker, Jeanne Reitz, Bob Huwe, Diane Barone, Jackie Berrum, Shane Templeton, Randy McClanahan, Jesse McClanahan, Terri Walsh, and Elaine Enarson. We would also like to thank the teachers and administrators who contributed ideas: Terry Terras, Joe Elcano, Marian Marks, Margaret Mason, Marge Sill, Pat Haller, Al Babb, Yvonne Shaw, Joan Mueller, Dan Carter, and Shirley Williams. And, thanks to members of the Research and Educational Planning Center office staff who prepared the manuscript: Sandra Walsh, Janet Oxborrow, Pat Downey, Ted Muller, Claudia Eaker, and Tina Wilkinson.

Introduction

"In the past ten years there have been many attempts to explain the sex differences in persistence and achievement in mathematics. Cases have been made for differences in brain development and lateralization, in spatial ability, in hormonal balance—even for the presence of a (male) math gene. Such research has a tendency to excuse and preserve the status quo. Indeed, it implies that the differences are natural and necessary, universal, and therefore just. I, on the other hand, have been content to be more modest: I simply visited schools where these sex differences in achievement were minimal or absent and looked around. The same hormones, the same brain lobes, the same maturation patterns were at work as prevail elsewhere. But the young women were learning mathematics—principally, so far as I could see, because they had been given good reason to think they could and should."

—Patricia Casserly, "Encouraging young women to persist and achieve in mathematics," p. 12

This book will help you give young women those "good reasons" to think they can and should learn mathematics. As a math teacher, you know that mathematics is an important subject. However, you may not be aware of how math acts as a "critical filter" when students enter postsecondary school. Without a sound advanced mathematics background, students are excluded from a large portion of college majors. This book is designed to help you to build a foundation of math skills and attitudes for students in grades six through nine, so that when they reach high school, they will want to take as many math courses as possible and will become high math achievers.

During their early school years, students develop the skills and attitudes toward learning that form the basis for future academic growth. If students develop a negative learning pattern toward a subject, it is extremely difficult to change. We know that when girls reach adolescence, a number of factors may combine to produce strong internal (attitudinal) and external (societal) barriers to reaching their mathematics potential. Therefore, it is vitally important that junior high and high school teachers do all they can to reverse negative patterns and build girls' positive attitudes and skills in mathematics. This will help girls withstand later societal pressures, continue math studies, and feel free to select math-related careers.

This guide includes strategies, activities, and resources that deal with five major topics: Attitudes and Math, Math Relevance, the Learning Environment, Other Issues, and Mathematics Promotion. Within each of these major topic areas are several subtopics.

Each chapter of this guide begins with a discussion of research findings on the practices and/or student attitudes that affect girls' math attitudes and performance. Strategies, activities, and resources that you can use to address each topic are described. Each chapter ends with an annotated resource list of materials that contains valuable ideas and activities.

Because many of the subtopics in the guide are interrelated, several of the strategies, activities, and resources are appropriate for more than one area. In those cases, the reader is referred to the appropriate section for additional information.

To use the guide, first read the pages introducing each subsection to gain an overview of research results and strategies. Most, but not all, of the activities in this book include math skill practice while covering the topic areas of concern. Review them to see how the math activities fit with what your students are currently learning. An index of activities referenced by math concepts/skills is also included at the end of the guide. You may use the topic ideas, but modify the math portion of the activity to better fit your students' needs.

The sections on attitudes and math relevancy were placed at the beginning of the book for two reasons. First, because these two issues—negative and stereotypical attitudes about girls and math and lack of information about math usefulness and relevancy—form the basis for many problems that surface later. And second, because we know that teachers usually devote little or no time to such topics. We encourage you to devise ways to spend more class time exploring and remediating negative attitudes and stereotypes and explaining why math is important; the time lost from math drill and practice will be more than returned when students approach the subject with positive attitudes and a high level of interest.

Another point that needs to be stressed is that although the activities and strategies suggested in this guide are particularly focused on providing equitable math instruction for girls, their use can benefit all students. All of the suggestions are based on research findings, published resources, and practical ideas from math teachers. They represent sound educational practice and, when used as part of your mathematics curriculum, will provide a positive learning environment for both boys and girls. The book is based on the premise that we can encourage students' positive feelings as well as provide information about mathematical facts and processes. All students will benefit from this approach.

Part 1

Attitudes and Math

This section contains suggestions that will

1. help you build students' math confidence
2. raise students' aspirations and expectations
3. change detrimental attribution patterns
4. deal with sex-role stereotyping and stereotyping of mathematics as a "male' subject

Each of the following attitudes can deter a young woman from taking advanced math courses: having low self-confidence about her math abilities, having low expectations for success in math, attributing failure in math to lack of ability; and viewing math as "unfeminine." When these attitudinal factors are combined, they can form an almost impenetrable barrier to math for a young woman.

Many psychologists believe that changes in attitudes can follow, rather than precede, changes in behavior. The following section includes ways to encourage girls to exhibit positive behaviors toward mathematics.

Building Math Confidence

Researchers have consistently found that confidence in math is directly related to later math achievement and decisions to enroll in elective high school math courses. There is no difference in girls' and boys' self-confidence in their mathematical ability in the primary grades. However, by grade six, boys have more confidence, even though their math test scores and grades are not any higher than those of girls. This difference in confidence becomes more pronounced and more detrimental for girls as they reach high school. A sample of research findings on math confidence is listed below.

- At each grade level from six through eleven, boys are more confident of their math abilities. (Fennema and Sherman 1978)
- At all grade levels, girls are more likely to experience "math anxiety"—an extremely debilitating fear of mathematics. (Boswell and Katz 1980; Tobias and Weissbrod 1980)
- Even though boys performed no better than girls in math at age 13, boys were much more confident of their math abilities. (Lantz, cited in Chipman and Wilson 1985)
- Bright female students are the most likely of any student groups to underestimate their chances of success in math. (Licht and Dweck 1983)
- Even female math graduate students who were achieving on a par with male students doubted their own abilities to complete their degrees in mathematics. (Becker 1984)
- Students' confidence as math learners is strongly related to their perceptions of teacher encouragement. (Sherman, cited in Chipman and Wilson 1985)
- From elementary school to college age, girls consistently rate their intellectual abilities lower than do boys, despite the fact that girls generally get better grades and score higher on most aptitude tests. (Russo 1985)

Many research findings indicate that girls have less confidence in their mathematical abilities, independent of any real difference in performance. Thus, it is essential that elementary teachers work to develop girls' confidence in their math abilities, so that as math becomes more difficult in junior high and high school, girls will continue to feel that they have the ability to learn it.

Skolnick et al. (1982) suggest that tasks that offer success for each child feature many approaches with many possible answers and offer confidence-building opportunities for guessing, checking, and estimating. The strategies, activities, and resources described on the following pages are designed to help your students gain confidence in their math abilities.

Strategies

1. Build students' confidence by publicly and privately acknowledging their academic and intellectual accomplishments (not their effort); e.g., "Mary, you figured out that answer very well" or "Joanne, you're really learning to solve these problems. With a little more practice, you'll have no difficulty with algebra." Try to focus on the intellectual aspects of girls' performance rather than neatness, organizational skills, or "just trying."

2. Practice is extremely important in building confidence. Make sure that girls get enough practice so that they can feel confident with their math skills.

3. Another confidence-building method that encourages student involvement without individual risk is the use of slates. Although this technique is most often associated with the elementary grades, teachers have found that junior high students also enjoy using slates. With slates, all the students can show you their answers at the same time, and you can determine how well you have done in teaching the concept.

4. Try to structure math learning activities so that all students will be able to achieve success at some level.

5. Incorporate some math problems that call for many approaches with several right answers. Stress the idea that, in most cases, there is more than one way to solve a problem.

6. Provide opportunities for estimating, guessing, and checking.

7. Recognize students' math achievement, especially improvement, by creating a "Math Star" bulletin board. Recognize students' outstanding math performance in the school paper.

8. Girls are often reluctant to recognize and acknowledge their own ability—especially in mathematics. Help them learn that it's okay to say, "I'm very good at math." It's not always easy for us to acknowledge our own abilities. If you are a female teacher, try setting an example for girls by saying something like, "I've always been good at math."

9. A current trend in educational practice is to create more opportunities for cooperative learning and minimize overt competition between classmates. Efforts to utilize groups where everyone must participate equally and will be given feedback collectively can be beneficial in building girls' math confidence. See the "Encouraging Cooperative Learning" section in this guide for further information.

10. Practicing math skills on computers can also build confidence. Select software that is appropriate for the skills your students need and that provides sound, positive feedback. Interact with students using computers by praising their accomplishments.

11. If you or any of your students are anxious about math, you might want to look at two books on the resource list: *Mind over math* by Kogelman and Warren and *Overcoming math anxiety* by Tobias. Both of these books include excellent suggestions for helping people become more comfortable with mathematics.

12. Turn the tables in class, and let students take turns asking the teacher questions about math. This technique can generate some good discussion and promote the idea that "there's no such thing as a stupid question." In fact, questions become the learning environment norm with this practice.

13. Use girls as peer tutors in math. Being asked to help others will definitely build the confidence of the tutor. Tutoring also helps both students gain increased understanding.

Activity

More or Less Game

Objective

To build confidence by giving students practice recognizing relative sizes of decimals and fractions

Grade Level

Grades 6–9 (You can vary the complexity, depending on how you number the cards and the rules you set for the game.)

Math Concepts/Skills

Comparing and ordering fractions and decimals

Time

15 minutes or longer per game, depending on the number and ability levels of players in each small group (You may use this game as an activity for students who have finished an assignment early.)

Materials

Deck of 50–100 numbered cards

Procedure

Construct the cards by cutting 3" x 5" cards in half and numbering each of the resulting 3" x 2 1/2" cards with a decimal or a fraction. The numbers do not have to be sequential. You could for example, use numbers such as .738, .591, .4, .16, .338, 2/3, 1/9, 2/8, 5/7, 3/6, and so forth. Vary the difficulty, depending on your students' skill levels. Since the object of the game is to decide which number is greater or smaller, it would be best not to include equivalent fractions or decimals in the pack.

The game should be played in small groups of 3–6 students. Deal five cards to each student, and turn one card face up from the pack to start the game. Place the turned-up card in the center of the playing surface. Moving clockwise around the group, each student plays *one* of his or her cards by laying it face up to the right if it is *more* than the faced (played) card or to the left if it is *less* than the faced card.

In the example below, card .671 was turned face up to start the game. The next player played 2/4 (less than .671) to the left. The next player played .699 (more than .671) to the right; 9/12 (more than .699) was then played to the right, and so forth.

A player who does not hold a playable card draws one from the pack and waits until her or his next turn to play. All players must monitor the game to be sure that no errors are made in placing the cards. If a player makes an error, the card must be placed back in his or her hand and another card drawn from the pack. Then the player must wait until his or her next turn to play a card. The object of the game is to play as many cards as possible and/or be the person with the fewest total "points" left in his or her hand. The game ends when one player is out of cards or when no one else can play and all of the cards in the pack have been drawn. At this point, players with cards left in their hands must add the card values to determine the number of points they have accumulated.

Less ◄-------- Original --------► More

1/3	.416	2/4	.671 (turned card)	.699	9/12	.86	11/12

Variations

1. To make the game very simple, use only fractions with denominators less than seven or only decimals or only integers, and play only to the left and right as above.

2. To make the game more challenging, use fractions with larger denominators; deal more cards to each student; and/or allow students to play sideways, "up" (for less), and "down" (for more) from the already played cards as in Scrabble. When using large denominator fractions, it would probably be a good idea to assign one student as game monitor. That person could use a calculator to check decimal equivalents of all fractions.

   Example

				(Less) .119	
		(Less) 5/9	?	(Less) 1/8	
(Less) 2/3	(Less) .679	(Less) .71	3/4	(More) .795	(More) .833
	(More) 7/10	7/9	(More) .873	?	(More) 6/7

   In the example above, the space above the original "3/4" would be unplayable because the card played would have to be more than 5/9, less than 3/4, but also less than 1/8! Similarly, the space below the .795 would be unplayable, but card 7/9 can be played because it is more than 7/10, more than .71, and less than .873.

3. To emphasize cooperative learning, make the object of the game be that the total group play as many cards as possible. Students can develop and discuss strategies for maximizing the number of cards played by the group.

Activity

Many Answers

Objective

To demonstrate to students that many problems have more than one "correct" answer; to allow all students to experience success and thus build confidence

Grade Level

Grades 6–9 (complexity can vary)

Math Concepts/Skills

Working with whole and mixed numbers, solving equations, solving problems, calculating volume

Time

10–15 minutes (You may use one or two of the questions in this activity as a daily "warm-up" or "sponge" activity for students who have extra time after completing the class assignment.)

Materials

Slates, blank 5" x 8" response cards or pieces of scratch paper, "Sample Questions" worksheet on the following page

Procedure

Use appropriate sample questions from the list on the following page, or construct your own. After students have shown their answers, determine how many different correct answers were given for each question, and discuss the idea of multiple approaches and correct answers with students.

Variations

1. Let students prepare and submit ideas for questions along with all the correct answers they can think of.

2. Give students a number, say "12," and see how many ways they can think of to add or multiply whole numbers or fractions to get this result.

3. The game of cribbage uses the principle of adding card values to reach 15. Teach your students to play cribbage in its regular form or vary the target number—use 12 or 23, for example.

4. Use real-life problems that have many answers. For example, if Mary's allowance is $15, how could she spend (or save) it?

Worksheet

Sample Questions

Give as many different answers as you can to the following questions:

What four whole numbers add up to 12? ______ + ______ + ______ + ______ = 12

What three whole numbers between 1 and 9 equal 10? ______ + ______ + ______ = 10

What six whole numbers add up to 18? ______ + ______ + ______ + ______ + ______ + ______ = 18

What three whole numbers between 1 and 9 equal 20? ______ + ______ + ______ = 20

What mixed number and whole number between 1 and 9 could be multiplied together to get 6?

______ x ______ = 6

What mixed number and whole number between 1 and 9 could be multiplied together to get 10?

______ x ______ = 10

What are three subtraction problems that would give the difference 789.371?

What are three addition problems that would give the sum 14,679.318?

What values of x makes the following statement true? $x + 5 < 9$

What values of x and y can be substituted in the following statement? $x + y = 8$

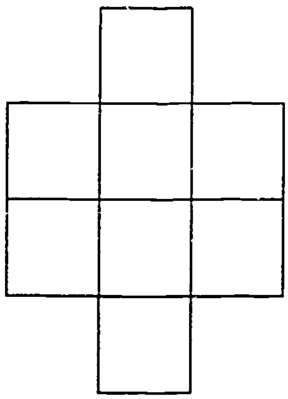
What values of x and y can be substituted in the following statement? $x - y = 9$

What values of a, b, and c can be substituted in the following statement? $2a + b - c = 12$

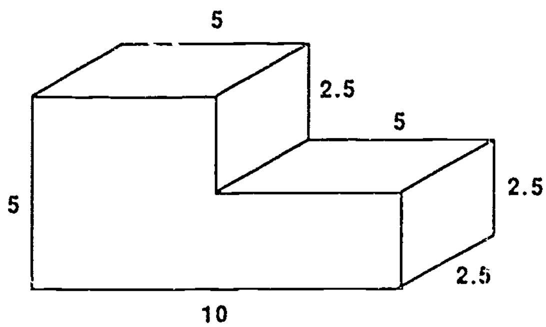
What values of a, b, and c can be substituted in the following statement? $a/3 + 4b - 6c = 8$

What values of a, b, and c can be substituted in the following statement? $1\ 1/2a - 3b \times c = 24$

Arrange the numbers 1 through 8 in these squares, so that no consecutive numbers are next to each other either horizontally, vertically, or diagonally.



What are two ways to calculate the volume of this object?



Activity

I Am the Greatest! Game

Objective

To give students practice in reading large numbers and assist them in learning place value ("Variations" includes practice in determining probabilities.)

Grade Level

Grades 6–8

Math Concepts/Skills

Working with whole numbers and decimals, determining place value, probability

Time

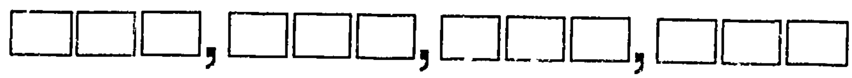
10 minutes per game

Materials

Chalkboard, numbered cards or tickets, small jar

Procedure

Cut out 20–30 small (1" or 2" square) cards, and number them 0 through 9. (You will have two or three of each number.) Draw twelve large squares with three large commas on the board.



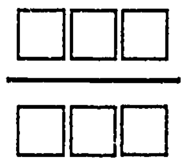
Tell the students that the object of the game is to create the largest twelve-digit number. Ask each student to draw the same squares on scratch paper. Put the numbered cards in the jar. Shake the jar to mix the numbers, draw out the first number, and announce it to the class. The students then write the number in one of their squares. Continue to draw and announce each number. Make sure students put their pencils down between numbers—no erasing or changing allowed. After you have drawn twelve cards, all students should have constructed a twelve-digit number.

Ask the students to write their numbers out in words. Ask who has the greatest number. The student who thinks he or she has constructed the largest number reads it out loud (and is required to read it correctly). Ask if any one has a larger number. Arrange the drawn numbers in order of magnitude to determine the largest possible twelve-digit number that could have been constructed. Ask the students who came up with the greatest numbers to explain their strategies.

Variations

1. To vary the game, play "I Am the Least!," in which students try to construct and correctly read the smallest possible twelve-digit numbers.
2. If students have difficulty with twelve digits, or if time is short, use fewer digits.
3. Play the game with the following squares:

Require students to read and/or write their decimal number correctly. They can also construct largest or smallest fractions:



4. This game can be used to help students learn to determine probabilities. Use the cards to give students some preliminary probability experiences, and let them see how you can change the odds that a particular number will be drawn.

   a. Use an original group of 10, 20, or 30 cards; draw and *replace* the cards in the jar after each drawing. After each number is drawn, ask students what the chances of drawing that number were. Ask, "Does it make any difference in the probabilities if we have 10 cards or 30 cards in the jar?"

   b. Use 10, 20, or 30 cards (one, two, or three of each number). Draw, but *do not replace,* each card. Ask students if and how this changes the chances each number will be drawn or how the rules of the game affect their strategy?

Activity

Guess and Check

Objective

To provide an accepting environment in which students feel free to guess, minimizing the pressure for answer accuracy; to practice a guessing and checking strategy for problem solving

Grade Level

Grades 6–9

Math Concepts/Skills

Guessing and checking, probability

Time

20 minutes or longer

Materials

"Guess and Check" handout on page 16

Procedure

It is extremely important to help students feel free to guess, but it is also very difficult to accomplish this. Conducting a short preparatory activity during which students guess something they have no idea about—like the weight of a jet plane or the distance from Venus to Mars—can help because students realize that no one knows all the answers. This can be tied to a library activity in which students find the answer.

Ask students to work the problems on the handout by first guessing the answers. Then check the guess by working the problem with that value. Explain how we can use even "wild guesses" to find the answer, because when we check, we learn the direction and magnitude of our errors. Let students make up their own problems to submit along with the answers to the problems on the following page.

Answers:

1. We know our guess for one student has to be somewhere between \$0 and \$95. Let's guess that Bob spent \$50. Check: Nancy = \$25 and Sue = \$75; \$25 + \$50 + \$75 = \$150—too much. Guess that Bob spent \$30; then the amounts would be \$15, \$30, and \$55 = \$100—close. Guess \$28; then \$14 + \$28 + \$53 = \$95—correct.

2. Guess the lowest activity first—the dance. Let's guess \$350; then the amount becomes \$350 + \$398 + \$474 + \$794 = \$2,016—way too much. Guess \$50; then we have \$50 + \$98 + \$174 + \$494 = \$816—much closer. Keep guessing. (Answer—the dance = \$75.)

3. George = \$12,000; Mary Ann = \$16,000; Randi = \$20,000; and Joyce = \$28,000.

4. Friday = 288, Saturday = 36, Sunday = 48, Monday = 288.

Variation

Encourage students to guess about many discrete items—e.g., how many petals on a flower, how many students have birthdays this month, how far is it from your town or city to some city in another part of the country. Assign one or more students to find the answers. Discuss how to use reasoning to make their guesses more accurate. For example, if we have thirty students in class, we might expect two to three of them to have birthdays in any given month (dividing the number of students by 12 months). Often we can estimate the distances if we can estimate the time required to traverse them.

Handout

Guess and Check

1. Nancy, Sue, and Bob (use names of your students) spent Saturday afternoon Christmas shopping. Bob spent twice as much money as Nancy and $25 less than Sue. If the total amount these students spent was $95, how much did each spend?

2. In preparing for their class trip, eighth graders at Elmcrest (use your school name and class grade) held four fund-raising activities. The bake sale netted $76 more than the book sale and $124 more than the dance. The school carnival netted $320 more than the bake sale. If the total amount raised was $916, how much did the students raise on each activity?

3. Mary Ann, George, Randi, and Joyce (use names of your students) graduated from college and got jobs this year. Randi majored in accounting, Mary Ann in social work, George in history, and Joyce in engineering. Randi's job pays 25% more than Mary Ann's. George couldn't find a job in his field so he had to take a temporary sales job at 25% less than Mary Ann's. Joyce is making $8,000 more per year than anyone else. The total salary for all four persons is $76,000 per year. What are their annual salaries? (Hint: Start by guessing Mary Ann's—it has to be divisible by 4.)

4. The Miller family took a four-day vacation. They drove the same distance on Friday and Monday, but only 1/8 as far on Saturday and 1/6 as far on Sunday. Total mileage for the trip was 660 miles. How many miles did they drive each day? Hint: Start by guessing the largest number.

Activity

"Guesstimating" and Measuring

Objective

To allow students to practice estimating and checking their answers through measurement; to build confidence in estimating and measuring skills

Grade Level

Grades 6–9

Math Concepts/Skills

Estimation, measurement

Time

15–30 minutes

Materials

Chalkboard, scratch paper, rulers or other appropriate measuring instruments, sample questions below

Procedure

The idea of this activity is to ask students, individually or in pairs, to estimate (or "guesstimate") a distance, weight, area, etc. (see examples below). Then, let students check their answers by actual measurement. Before the measurement process, discuss how students might find the answer. Each example includes more than one question, because it is beneficial for students to estimate, check, and then estimate a similar distance, weight etc. Unless students have a previous frame of reference, their first estimate will probably be closer to a "wild guess." Once they have estimated and measured the first problem, their estimates of similar problems will be closer to the actual answers. Point out to students that this is an area where practice really helps improve performance. Also, help students find familiar references they can use in estimating. For example, if you remember about how heavy a ten-pound bag of flour *feels,* you can judge whether an object is much heavier, much lighter, or about the same. If you know the length of your stride, you can estimate shorter distances. Students can use fingers, books, feet, arm length, etc. as frames of reference.

Use the examples below as ideas; let students think up their own questions for the class.

Examples

How many feet wide is our classroom? How many feet long?

How far is it from our classroom to the school cafeteria? to the gym?

How many shoe laces are in the room right now? How many pairs of shoes?

Which of two persons is taller? What are their heights? (Compare several persons, without having them stand side-by-side.)

Which of these objects weighs more? What are ways we could find the answer? (Compare several different examples in class.)

Which of these containers holds more water? What are some ways we could measure the amount of water each holds? (Compare several containers of various sizes.)

How long is a minute? (Have students signal when they think a minute has elapsed.) How long is 75 seconds? two minutes?

What is the area of the chalkboard in this room? What is the area of the top of the teacher's desk?

Using a map with a distance scale, estimate how far it is between two points? between another set of points? (Have students measure to verify rather than adding mileage numbers.)

Variation

Develop some guesstimating problems to use as take-home assignments, including some questions for which answers can be estimated at school and then measured at home. For example, how many square feet are there in your kitchen? How far is it from your house to school?

Activity

Fraction Grids

Objective To build confidence in the ability to understand and use fractions by using manipulatives

Grade Level Grades 6–9

Math Concepts/Skills Multiplying and dividing fractions

Time 20–30 minutes

Materials "Fraction Grids" handout on the following page, paper, rulers, pencils

Procedure Copy and laminate the "Fraction Grids" handout for each student. The grids can be used in a variety of activities with fractions, and they are especially helpful for visualizing relationships between fractions. You can ask a variety of questions about adding and subtracting fractions, which students may answer by looking at the grids. Students can also shade or cover sections of the grids to represent multiplication, for example, what is 1/3 of 1/2? Look at only the right side of the 1/2s grid; mark it off into 1/3s. How large is one of these thirds? Another example might be: What is 2/5 of 1/4? Look at one section of the 1/4 grid. Mark it off into fifths; how large are two of these fifths?

To help students understand division with fractions, use the grids with the problems listed below. *Note:* For division, students may need to draw additional grids and also equal length undivided strips.

a. What is 1 divided by 1/4? or How many 1/4s are there in 1? Look at the grid divided into 1/4s; how many 1/4s are there? What is 2 divided by 1/4? or How many 1/4s are there in 2?, etc. Use the concrete model to supplement mathematical substitution, so that students can see the development of the division algorithm.

b. What is 1 divided by 2/3? or How many groups of 2/3 are there in one whole unit? Look at the grid divided into thirds. Consider 2/3 (or 2 boxes) as a *new unit.* How many of these units are in the original? (Answer = one) What is left over? (Answer = one additional box) The remaining piece containing one box is 1/2 of the 2-box unit. Thus, there are 1 1/2 portions of 2/3 in the whole unit one. How many 2/3s are there in two units?

These grids can also be used to illustrate division of fractions by other fractions. Refer to the article by Curcio et al. (1987) for additional ideas on using a representation of equivalent fractional parts to teach concepts in division by fractions.

Handout

Fraction Grids

1

1/2 1/2

1/3 1/3 1/3

1/4 1/4 1/4 1/4

1/5 1/5 1/5 1/5 1/5

1/6 1/6 1/6 1/6 1/6 1/6

1/7 1/7 1/7 1/7 1/7 1/7 1/7

1/8 1/8 1/8 1/8 1/8 1/8 1/8 1/8

1/9 1/9 1/9 1/9 1/9 1/9 1/9 1/9 1/9

1/10 1/10 1/10 1/10 1/10 1/10 1/10 1/10 1/10 1/10

Activity

Math Myths

Objective

To make students aware of myths about mathematics that tend to have a negative effect on girls' math confidence; to help students destroy these myths through rational discussion

Grade Level

Grades 6–9

Time

Several 10–15 minute segments

Materials

"Math Views—Do You Agree?" worksheet on page 24

Procedure

Duplicate the list of math views, and have students anonymously complete the survey. Discuss each question with students, helping them break down the myths they hold. Use the supplementary material below for class discussion.

To add a math activity to this exercise, have students tally responses and compute the percentages of students who agreed with each statement.

Supplementary Material for Discussion

1. *Boys are naturally better at math than girls.* Research has failed to show any difference between men's and women's mathematical *ability*—both are equally capable of doing math. The most important elements in math scores are general intelligence, motivation, attitude, and interest. We can sometimes see differences in individual math achievement, and fewer girls tend to enroll in advanced math classes mainly because they think math is a subject more appropriate for boys.

2. *Math requires only a very logical mind.* Although few people are aware of it, intuition plays a major role in solving math problems. Many of the great mathematical discoveries and inventions came about through intuition, not logic. Working out a process by which you can prove that the answer is correct does involve logic. Math books often give the impression that math requires an especially "logical mind," because they present math as orderly, precise, and logical. Solving mathematical problems is actually the result of using intuition, making false starts, checking, persisting, and trying out ideas until the solution is "seen."

3. *In rder to find a correct answer, you must always know how you got that answer.* Often you can get the correct answers to problems without knowing how you got them, because getting the answer involves intuition, and deriving the answer requires logic. It is important to know the process by which you found an answer, so that if you're wrong you can see where you are going wrong and correct the error, and if you're right you can apply the process to similar problems. But you can often get the correct answer without knowing the process.

4. *Math is not creative; it's simply hard work.* Solving a math problem requires overcoming a difficulty in an imaginative way. Creativity can be seen in all aspects of solving math problems—even in the different ways people do arithmetic.

5. *There is always one best way to do a math problem.* Each math problem can be solved in a variety of ways—some are easier and quicker and may be less exact; some are more difficult, take more time, and may give more exact answers. The "best way" depends on how exact an answer you need and what you feel most comfortable with.

6. *It's always important to get the answer exactly right.* Often, it depends on why you need the answer. If your doctor is figuring the amount of a very strong and dangerous medicine to give you, you'd like to be sure of a very exact answer. Or, if you're taking a test, you usually need to find the answer to so many decimal points. But in other situations, the ability to obtain approximate answers is more important than getting exact answers. For example, if a computer is solving a problem, you need to be able to determine if the answer is close to what it should be. That's why it's important to learn to estimate and approximate as well as to figure exact answers.

7. *It's wrong to count on your fingers.* There is nothing wrong with counting on your fingers as an aid to doing arithmetic. Most people find this very helpful. We use calculators and computers to help us do math. The Chinese use the abacus, which is really a counting machine that provides a fast and accurate aid to doing arithmetic.

8. *People who are good at math do problems quickly, in their heads.* Solving new problems or learning new material is always difficult and time consuming. The only problems mathematicians do quickly are those they have done before. Speed really doesn't have much to do with math ability; it usually just means that a person has practice in answering those types of problems. We often do need to solve problems quickly on tests, however.

9. *Math requires a good memory, and memorizing formulas and rules is the best way to learn it.* Knowing how to do math means that the concepts make sense to you and that you understand the rules and formulas. Memorization of rules and formulas doesn't help you do this, especially as problems become more complex. Understanding takes time, and it often takes trying more than once. In the long run, it's definitely better than memorization.

10. *To solve a difficult problem, work intensely, and don't stop until the problem is solved.* Solving math problems requires both working intensely and resting. Taking a break from the problem, thinking about something else, and then returning to it often allows your mind time to go over the material and come up with new "insight" that helps in the solution. Resting doesn't mean giving up on a problem; it just means putting it aside with the idea that you'll come back to it and solve it later. Just sitting down and working hard till you finish is a good strategy for doing simple arithmetic like adding columns of numbers, but it is not the best strategy to use in learning new concepts or solving difficult math problems.

11. *There is a "math mind"—some people have it and some don't.* Sometimes people think that there are two kinds of brains—one that grasps math easily, quickly, and naturally and the other that just "can't get" math. That is absolutely untrue. We all have brains that work the same way, and there is no "math gene."

12. *There is a magic solution to help you do any math problem.* There is no formula or rule that will suddenly make math easy. Learning to do math requires everyone to use the same skills they use to learn anything else.

Worksheet

Math Views—Do You Agree?

Below are some commonly held views about math. For each statement, mark whether you agree, disagree, or are undecided.

	Agree	Disagree	Undecided
1. Boys are naturally better in math than girls.	____	____	____
2. Math requires only a very logical mind.	____	____	____
3. In order to find a correct answer, you must always know how you got that answer.	____	____	____
4. Math is not creative; it's simply hard work.	____	____	____
5. There is always one best way to do a math problem.	____	____	____
6. It's always important to get the answer exactly right.	____	____	____
7. It's wrong to count on your fingers.	____	____	____
8. People who are good at math do problems quickly, in their heads.	____	____	____
9. Math requires a good memory, and memorizing formulas and rules is the best way to learn it.	____	____	____
10. To solve a difficult problem, work intensely, and don't stop until the problem is solved.	____	____	____
11. There is a "math mind"—some people have it and some don't.	____	____	____
12. There is a magic solution to help you do any math problem.	____	____	____

Math myths and supplementary information from Kogelman and Warren 1978.

Resources

Burns, M. 1975. *The I hate mathematics book.* Boston: Little, Brown.

For those students who "seemingly" hate mathematics, this book provides many relevant activities to boost confidence and aspirations. Positive attitudes toward mathematics develop as students experiment with and investigate the uses of mathematics in solving everyday problems. The activities are presented in a way that encourages students to have fun with mathematics.

Cook, M. *Math materials.* Catalog. Balboa Island, California.

These materials include tiling sets, task cards, and books designed to add variety to math. The materials emphasize problem solving and focus on active student involvement. Also included are several books on cooperative learning. A catalog is available from Marcy Cook, P. O. Box 5840, Balboa Island, CA 92662.

Curcio, F.; Sicklick, F.; and Turkel, S. 1987. "Divide and conquer: Unit strips to the rescue." *Arithmetic Teacher* 35, no. 12: 6–12.

This article contains interesting suggestions for using partitioned unit strips help students conceptualize multiplication and division by fractions.

Downie, D.; Slesnick, T.; and Stenmark, J. K. 1981. *Math for girls and other problem solvers.* Berkeley: University of California, Math/Science Network.

The activities in this book encourage independent thinking and creativity in mathematics. Students and teachers are encouraged to think about problem solving in versatile ways and forms. Although this book was originally designed for females, the activities are appropriate and interesting for both boys and girls ages 7–14. This book would also be an excellent resource for math clubs.

Holden, L. 1987. "Math: Even middle graders can learn with manipulatives." *Learning 87* 16, no. 3: 52–55.

If fractions are frustrating for your students, this article includes many ways that manipulatives can be used to help middle school students understand fractions and learn geometric concepts.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. The purpose of the program is ultimately to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes sections with activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction.

Kogelman, S., and Warren, J. 1978. *Mind over math.* New York: McGraw-Hill.

This entertaining book debunks twelve math myths, explores the roots of math anxiety, and demonstrates that doing math is not really so different from any other skill. A math practice section contains excellent sample problems and instructions on how to solve them.

Skolnick, J.; Langbort, C.; and Day, L. 1982. *How to encourage girls in math and science: Strategies for parents and educators.* Palo Alto. CA: Dale Seymour Publications.

This excellent resource examines the effect of sex-role socialization on girls' math/science skills and confidence. It explains how attitudes, parenting and teaching practices, stereotypical play activities and books, peer pressure, and career and family expectations cause girls to question their abilities in math and science, and thus hinder their development in these areas.

In addition to a summary of the socialization process, this book contains a variety of compensatory educational strategies and activities that may be used to encourage females in mathematics. These particularly focus on increasing math confidence, spatial visualization skills, and problem solving and are designed for primary through junior high school students. Both parents and educators can benefit from this book.

Souviney, R. J. 1981. *Solving problems kids care about.* Palo Alto, CA: Scott, Foresman.

Solving problems kids care about is divided into two parts. Section 1 includes notes and strategies for teaching mathematical problem solving. Section 2 contains thirty selected real-world problems that encourage divergent and logical thinking. Many of the problems have a range of acceptable solutions and multiple solution strategies, so students have the opportunity to be creative, independent thinkers. Activities are designed for elementary through junior high school students; teachers will enjoy them also.

Stenmark, J. K.; Thompson, V.; and Cossey, R. 1986. *Family math.* Berkeley: University of California, Lawrence Hall of Science.

If mathematics promotion is a goal of your teaching, *Family math* activities will help you introduce parents and children to ideas that improve their math skills and help them gain an appreciation for math. Topics are geared to the K–8 math curriculum. Hands-on mathematical experiences provide families an opportunity to develop problem-solving skills by looking for patterns, drawing pictures, working backwards, working cooperatively with a partner, and eliminating possibilities. The mathematical concepts learned in *Family math* are spatial relationships (geometry), estimation, data interpretation (probability and statistics), and mathematical reasoning.

Tobias, S. 1978. *Overcoming math anxiety.* New York: W. W. Norton.

This classic book provides an analysis of the origins of math anxiety and suggestions for overcoming it. It includes sections on word problem solving, everyday math, and calculus.

Raising Math Aspirations and Expectations

Students' educational aspirations, or goals, are highly correlated to mathematics achievement. Generally, girls' aspirations for future math education are lower than those of boys; their expectations for success in math are also lower. In many cases, these aspirations and expectations are learned from and reinforced by parents and teachers.

- Although during the early elementary school years, boys' arithmetic scores do not exceed those of girls, boys develop higher expectations for their performance than do girls. (Russo 1985)
- As compared to girls, boys in grades five through twelve had higher expectancies for success in their current and future math courses. (Wigfield 1984)
- Parents have lower expectations for girls' than for boys' math achievement (Fox 1977); teachers expect less of female students in math. (Cartledge 1984)
- In classrooms where bright girls had lower expectations for mathematics success, they received less praise and instruction from teachers. (Eccles [Parsons] et al. 1985)
- Parents consider math more difficult for girls than for boys, and they believe that girls have to work harder than boys to do well in math courses. (Eccles [Parsons] et al., cited in Stage et al. 1985)
- Parents chose more selective colleges for their sons than for their daughters, even though both groups of students were extremely high math achievers. (Franklin and Wong 1987)

Even when girls are achieving on a par with boys, they have lower expectations for success in math, and they plan to take fewer advanced math courses. We need to counter these attitudes by helping girls raise their expectations and aspirations. We also need to work to change parents' attitudes. Some ideas for working with parents can be found in the "Mathematics Promotion" section of this guide. The strategies, activities, and resources described in this section are designed to do just that.

Strategies

1. As a teacher, you help students set their aspirations for education and careers. Much depends on how students perceive your (and their parents') expectations for them. It is important that you hold high (but not unrealistically high) expectations for students, and that you encourage them to aim as high as they want when considering their future education and occupations.

2. To raise career aspirations, students must be exposed to information about careers. Use the activities and strategies in the "Math Relevance" section of this guide to help students learn about math-related careers.

3. Because students' aspirations are so closely related to their parents' expectations for them, it is very important that you help parents raise their expectations. Use some of the "Tips for Parents of Girls" in the "Mathematics Promotion" section to get this message across.

4. Let students set their own expectations for grades by using the goal-setting sheets described in the "Learning Environment" section of this guide.

5. To help raise educational aspirations and prepare your students for decisions they will have to make in high school, talk about the math courses they will be taking in high school and college. Explain the types of things they will learn in algebra, geometry, trigonometry, calculus, statistics, and so forth. Try to take the "mystery" out of these subjects by relating current math topics to the content of these courses.

6. It is widely recognized that students enjoy the discovery provided by science study, but few science teachers use science as a way of raising career aspirations. Try working with one or more of your school's science teachers to help students become interested in math and science careers. Allow students to ask questions about scientific and technical careers to encourage them to expand their horizons and to consider nontraditional occupational choices. Using the resource materials in the "Math Relevance" section, you can easily relate in-class math study to science careers. Girls whose interest appetites are whetted will benefit from knowing the usefulness of their math assignments.

7. The strategies and activities listed in the subsection on role models can raise educational and career aspirations for girls. The supplementary materials on women in math-related careers help girls become aware of other women who possess high aspirations.

8. Teachers can provide direct recognition and invaluable support to students via private comments relating careers to students' abilities. Unless girls know their teachers have faith in their individual success, they will not be inclined to pursue highly competitive technical careers. Don't overlook other opportunities to link student success in a concept area to its usefulness in the real world.

Activity

I Can Be Anything—What Will I Be?

Objective — To encourage students to think about their futures; to promote an environment in which daydreaming about the future is encouraged

Grade Level — Grades 7–9

Math Concepts/Skills — Calculating and using statistics, constructing bar graphs

Time — Two 30-minute segments

Materials — Paper and pencils

Procedure — Hand out the following passage to students, and give them time to read it carefully. Ask students to respond, in writing, to their specific daydreams.

> You are an adult now. Think about what your life is like. Think about where you live. What does your house look like? Do you have a family? What do you like to do for fun?
>
> What kind of job do you have? Pretend it is a typical work day for you. Where do you work? What is your workplace like?
>
> Now imagine your job. Do you work alone or with other people? What do you do first when you get to work? What do you do next?
>
> At the end of the day, how do you feel about your job? What do you like best about your job, and what do you like least about it? Why did you choose this particular job?

After reading students' written responses, compare male and female students' career aspirations and potential use of mathematics. Ask the students to tally responses on various aspects of the daydream—e. g., home or family, kind of job, like best about job, like least, and so forth, and summarize. Have students make bar graphs of their findings.

Lower career aspirations for girls can serve as a springboard for discussion. If many girls see themselves as homemakers rather than workers, use some of the materials in the "Math Relevance" section to help them understand the need to plan for careers. Many students may be unable to picture themselves in a job. Junior high students typically have been exposed to a very narrow range of careers. Use the discussion and materials in the "Math Relevance" section on careers to help students begin considering a wider range of career options. You may want to repeat this activity after a few months, let students tally responses and compare old and new bar graphs.

Activity

Describe This Job

Objective
To provide a model for visualization of career choices; to elevate girls' career aspirations

Grade Level
Grades 6–9

Math Concepts/Skills
Calculating statistics and constructing graphs

Time
Three 30–40 minute segments covering (1) responses, (2) data collection and summary, and (3) discussion

Materials
Used copies of popular magazines and the "Describe This Job" worksheet on the following pages

Procedure
Ask students to sort through magazines such as *Forbes, Money, Newsweek, Vogue,* or *Working Woman* to locate four to eight pictures of women (and an equal number of pictures of men) employed or engaged in comparable technical positions—for example, women and men with hard hats, in suits with briefcases, or in lab coats. Make sure the numbers of women and men pictured in various types of occupations are equal; i.e., don't have six men in suits and only one woman in a suit.

Glue the pictures to a tagboard, and place them on the chalkboard, or pass each around the room. Allow the students to name each person, and write the name on each picture.

Expand the worksheet on the following page, depending on the number of pictures you are using. Ask each student to describe, in detail, the job each person holds by filling out the answer sheet, for example:

1. Where does Jennifer Barnes (or James Meyers) work?
2. What is her (his) occupation?
3. What kind of math does she (he) use at work?
4. Does she (he) have a family? How big is her (his) family?
5. What does she (he) like to do for fun?

Divide students into small mixed-gender groups of two or three. Have them summarize all of the data on a particular picture in graphs and charts. Let the class decide what type of graph would be most appropriate to display the information. Ask students to tally male and female student responses separately. Compare girls' and boys' responses to male and female pictures. The following are questions for class discussion of the results:

1. Were students' descriptions of the careers of the men and women in pictures similar or different?

2. Were girls' and boys' responses to the pictures different? Did either group see males or females in more professional careers?

3. Did girls or boys see differences in the math used by the men and women in the pictures?

4. Did girls or boys see differences in the families of females and males pictured?

This activity may also form the framework for a writing assignment (in English class), which students can share with the rest of the class. Ask students to add a brief description of what they would do and how they would act in Jennifer's or James's job, and submit the writing assignment. Respond to *all* students' math and career aspirations with a positive note of encouragement, but pay particular attention to the girls' aspirations.

Variation

In a related activity, each student can select the picture that best describes his or her ideal futures, and then describe the person, the job, etc.

Worksheet

Describe This Job

Your sex: Boy ______ Girl ______

Picture #
Name of person in the picture: ______
Where do they work? ______
What is their occupation? ______
Kinds of math used at work? ______
______
Do they have a family? ______ Yes ______ No Family size: ______
What are their hobbies and interests? ______
______

Picture #
Name of person in the picture: ______
Where do they work? ______
What is their occupation? ______
Kinds of math used at work? ______
______
Do they have a family? ______ Yes ______ No Family size: ______
What are their hobbies and interests? ______
______

Picture #
Name of person in the picture: ______
Where do they work? ______
What is their occupation? ______
Kinds of math used at work? ______
______
Do they have a family? ______ Yes ______ No Family size: ______
What are their hobbies and interests? ______
______

Activity

Your Education—What's It Worth to You?

Objective To encourage students to begin thinking about their future educational plans

Grade Level Grades 7–9

Math Concepts/Skills Calculating statistics

Time Three 15–20 minute blocks of time (procedures 1–2, 3–4, and 5 per time block)

Materials Scratch paper, graph paper, calculators, chalkboard, "Monetary Value of Education" table on the following page

Procedure Ask students to write down (anonymously on scratch paper) the number of years they plan on being in school and what degrees and/or training they plan to get. Mention all of the educational alternatives on the "Monetary Value of Education" table without giving any additional information. Explain that graduating from high school would require approximately 12 years of school, community college would require 14 years, college would require 16 years, and graduate and professional degrees would require 18–22 years.

Have the class tally up how many students are planning to graduate from high school, community college, etc., and construct a bar graph of this information.

Duplicate the "Monetary Value of Education" table, give students a copy, and let them study the figures.

Students can figure annual salaries for each level of training or degree and average annual salaries for themselves and the class as a whole.

Discuss the material. Then have students, again anonymously, write down the number of years they expect to be in school and the type of degrees they expect to earn. Ask them to write a brief paragraph on the reasons for their plans. Have students tally this data. Determine whether or not the students as a group have changed their educational plans based on the information presented.

Use this activity with "Who Goes to College," on page 35.

Variation Ask students to note their sex on their anonymous plans for years in school and degrees. Have the class make separate bar graphs for males and females before and after seeing the information, and compare.

Since this activity emphasizes "materialistic" reasons for education, you may also want to discuss how education contributes to the quality of life. Try to instill a sense of learning as being extremely valuable for its own sake.

Handout

Monetary Value of Education: Average Monthly Salaries

For people who:	*Amount per Month*	*Years in School*
Don't graduate from high school	$ 693	10–11
Graduate from high school	1,045	12
Attend college but don't graduate	1,169	13–14
Get vocational training	1,219	13–14
Graduate from a community college	1,346	14
Graduate from a four-year college	1,841	16
Graduate with a master's (M.S.or M.A.) degree	2,280	18
Graduate with a doctorate (Ph.D. or Ed.D.) degree	3,265	22
Graduate with a professional degree in law or medicine	3,871	22

From Kominski, R. 1987. *What's it worth? Educational background and economic status. Spring 1984.* Washington, D.C.: U.S. Bureau of the Census.

Activity

Who Goes to College?

Objective

To make students aware of differential educational achievements of men and women in the past; to give students practice in grouping data and graphing

Grade Level

Grades 7–9

Math Concepts/Skills

Working with whole numbers, place value, calculating percentages and ratios, constructing circle graphs

Time

30 minutes

Materials

"Educational Levels of Men and Women in the U.S.: 1984 Data" table on the following page, "Monetary Value of Education: Average Monthly Salaries" table on the previous page, protractors, and calculators

Procedure

Make a copy of the table for each student. Let students read the material and practice reading the numbers (converting from "in thousands" to actual numbers). Ask students to use a calculator to total the columns and then determine the percentages of males and females who earned each degree (i.e., 11.85% of males earned bachelor's degrees). Have students make a circle graph or pie chart (using the protractors) for each gender showing percentage of each sex who have attained each educational level. To simplify the graphs, students can combine the advanced degrees (doctorate, professional, and master's) into one category. They can also combine the associate and vocational levels into one category.

If this is the students' first experience with circle graphs, you may need to help by creating a circle graph master with some degree levels already marked on it. Or, at least draw a rough example on the board.

Discussion questions can include: What conclusions can be drawn about men's and women's educational levels? (Students can look at the numbers of women who receive the various degrees and discuss the impact on women's earning power by using the "Monetary Value of Education" table.) Why haven't more women obtained advanced degrees? Do you think this will change?

Variations

1. Ask students to express the numbers in one column as ratios of the corresponding numbers in the other column.

2. Another related extra credit project would be to have students do library research to find similar data from previous decades, compute percentages, and compare to current data.

3. If your students have access to computers and software with graphic capabilities, they can use the data from this activity to create and compare different types of graphs. Which type of graph makes the data easiest to understand?

Handout

Educational Levels of Men and Women in the U.S.: 1984 Data

Highest degree earned	(Numbers in thousands) *Males*	*Females*
Doctorate (Ph.D. or Ed.D.)	585	183
Professional degree (M.D., L.L.D., etc.)	1,432	312
Master's (M.S. or M.A.)	3,110	2,685
Bachelor's (B.S. or B.A.)	9,581	8,488
Associate (community college)	2,804	2,964
Vocational	1,023	2,082
Some college, no degree	15,444	14,857
High school graduate	26,407	33,951
Not a high school graduate	20,448	23,876

From Kominski, R. 1987. *What's it worth? Educational background and economic status. Spring 1984.* Washington, D.C.: U.S. Bureau of the Census.

Activity

Real and Ideal

Objective To help students begin to think about their futures

Grade Level Grades 7–9

Math Concepts/Skills Calculating statistics, constructing graphs and charts

Time Survey—20 minutes, data preparation—20–30 minutes, discussion—20 minutes

Materials "My Educational and Career Plans" worksheet on page 39

Procedure Duplicate the survey and ask students to anonymously complete it.

Before they answer, go over the questions with students. Make sure they are specific about their plans in terms of degrees or types of training, places of education, and types of occupations. Also make sure they understand that in the ideal situation (questions 1–3), they should answer as though they have the money, talent, and/or ability to do anything with no constraints.

Data Preparation

1. Working with the class, plan how you will analyze this data: How will it be summarized? How will answers be coded? (Note on coding: To summarize data from these open-ended questions, students will need to decide on 6–10 categories in which to place responses to each question. First scan the responses to see what types of codes could be used. For example, under questions 2 and 5 students might list specific colleges, the military, trade schools, and so on. A set of codes that summarizes the data might include professional schools, four-year colleges, two year colleges, trade schools, military schools, high schools, and so on.) What categories will be used? How will the data be presented? What type of graph or chart would be appropriate? Do we need one graph for each question? Do we want to do separate analyses for male and female students?

2. Divide the class into six mixed-gender groups of students to analyze the data.

   Group 1—Code the answer sheet for questions 1 and 4 for males; tally and prepare a graph or chart.
   Group 2—Code the answer sheet for questions 2 and 5 for males; tally and prepare a graph or chart.
   Group 3—Code the answer sheet for questions 3 and 6 for males; tally and prepare a graph or chart.
   Group 4—Code the answer sheet for questions 1 and 4 for females; tally and prepare a graph or chart.
   Group 5—Code the answer sheet for questions 2 and 5 for females; tally and prepare a graph or chart.

Group 6—Code the answer sheet for questions 3 and 6 for females; tally and prepare a graph or chart.

Discussion: Let each group present their findings to the class and discuss.

Discussion questions:

Did students' plans change between the ideal and real situations?

What stops us from realizing our "ideal world" goals?

How can we work toward making our "ideal" and "real" plans the same?

Variation

This activity would work well combined with an English or social studies and math class project. The worksheet could be done in English or social studies, and the analysis, interpretation, and discussion of data could be carried out in math class.

Worksheet

My Educational and Career Plans

Sex: _____ Female _____ Male

Think about the most ideal situation for you. Answer these questions as though you could do anything you wanted.

1. Suppose you could get any kind of training or education in the world, what would you get?
   Describe: ____
   ____
   ____
   ____

2. Where would you get this training or education? ____
   ____

3. If you could have any job or career in the world, what would you do? ____
   ____
   ____
   ____

Answer these questions by thinking about what your future will actually be like.

4. What kind of training or education do you think you will actually get?
   Describe: ____
   ____

5. Where will you get this training? ____
   ____

6. What job or career do you think you'll actually have when you are an adult? ____
   ____
   ____
   ____

Activity

This Is Your Lifeline

Objective

To increase students' awareness of the relationship between education and employment options; to give students practice in the following skills: graphing, sequencing, decision making, planning, and estimating

Grade Level

Grades 6–9

Math Concepts/Skills

Using statistics and graphs, estimating

Time

One class period—25–40 minutes

Materials

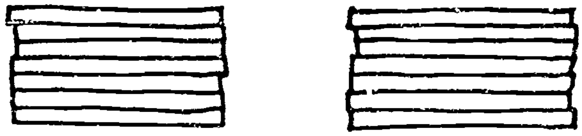
Each student needs one copy of "Student Instructions" (on the following page), one strip of adding machine tape (approx. 30 cm long), colored pens, scotch tape, and a metric ruler

Procedure

Tell students that they are going to imagine what will happen to them during their lives. Ask them to take a minute to list several things they think might occur. When they have made their individual lists, put a few of the items on the chalkboard to help other students think of things they might have missed.

Give each student the strip of tape along with the instruction sheet. Allow 15 minutes for them to complete their lifelines. Ask students to color all education years one color (e.g., blue) and all work years another color.

As the lifelines are completed, have the students tape them horizontally in columns on the chalkboard like this:



This class graph may be more significant if the lifelines for girls are put in one column and those for the boys are put in another.

The most important part of this activity is the open-ended discussion (see discussion questions below). Some students will have made unrealistic life plans. The discussion ties in the relationship between high school courses and employment options.

Some Questions for Discussion of "This is Your Lifeline" Graphs

Which is greater for most students, the time spent in education or in working? (Read from graph on board.)

How does education time compare with time after retirement? (Read from graph.)

Did many people chose to stay home with small children? (Read from graph.)

How long did most people work? (Read from graph.)

Was there a difference in the graphs for boys and girls? Who worked longer? Who attended more school? Who retired earlier?

What education is necessary for the career choices on the students' lifelines?

What careers will probably bring the highest salaries?

Some Relevant Facts

On the average, a married or unmarried American man works 45 years and retires at age 65. Over one-half of his life is spent in the workforce.

On the average, a married American woman works 25 years outside the home. The average unmarried woman works 43 years. Considering a woman's life expectancy today, this is over one-half of her life. There is a rapid increase in the number of woman working each year and a trend toward working more years.

A student planning his or her life might keep in mind the definite relationship between jobs that pay higher salaries and jobs that require a math background. Math skills allow maximum flexibility and opportunity in this technological world.

Math courses are sequential. Important decisions regarding high school courses are made in junior high school. To complete the precalculus sequence in most high schools, a student must acquire the basic skills in seventh and eighth grades, take Algebra I in the ninth, Geometry in the tenth, Algebra II in the eleventh, and Math Analysis and Trigonometry in the twelfth.

Calculus is considered elementary mathematics. We need to recognize it as a starting point, not an ending place. Without high school preparation, many students will eliminate themselves from many of college majors.

Many fields that previously required no math are becoming technologically oriented. Technology is used in such diverse occupations as food processing, milking cows, and running libraries. Advancement opportunities often depend on math and science backgrounds. Students will open many options by taking as much math and science as possible in high school.

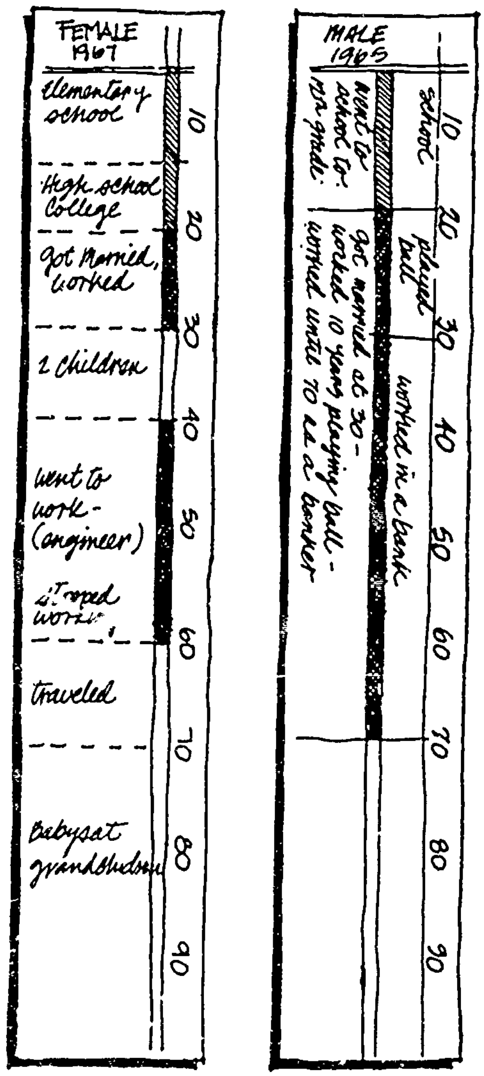
Handout

Student Instructions

You should have a strip of paper 30 cm long for your lifeline. You should also have made a list of the things you think will happen to you during your life.

Directions:

1. On one end, write whether you are a male or female.
2. Write the year you were born on the same end.
3. Assume that you will live 100 years. Along one edge of the paper, make a mark for each 10-year period. (Let 3 cm represent 10 years.)
4. Mark the year you started school.
5. Mark the year you plan to finish school. Do you plan to finish high school? college? get an advanced degree?
6. Mark the year you plan to first begin working full-time.
7. Mark the year you plan to retire from work or stop working. Are there times in your life when you stop working and then begin again after a few years? Mark those times.
8. Color all the education years with the color your teacher tells you.
9. Color all the employment years with the color your teacher tells you.
10. Fill in any other important dates on your lifeline.
11. Write in other information: What kind of job do you have? Do you marry? Do you have children?
12. Tape your lifeline onto the class graph.



Activity

Math Achievement Differences

Objective To make students aware of actual male/female differences in math achievement and enrollment; to focus a discussion on how these patterns can be changed

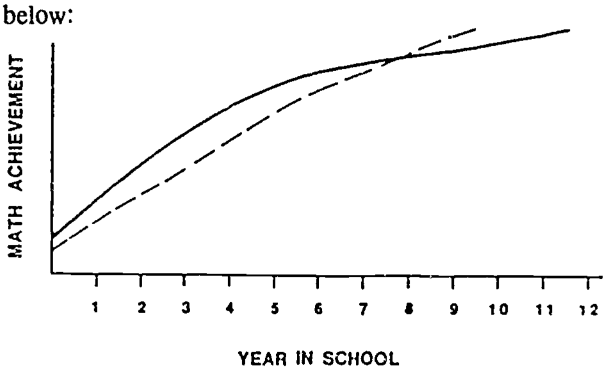
Grade Level Grades 6–9

Math Concepts/Skills Interpreting data from graphs

Time 20 minutes

Materials Chalkboard; graph sketched below; reading in Skolnick et al. (1982), pp. 37–46 (Reading is for teacher information, not students.)

Procedures Bring male/female differences in math achievement out into the open with your students. Begin by drawing a graph with "Year in School" on the x axis and "Math Achievement" on the y axis. Draw, but don't label the two lines as in the sketch below:



Let students discuss the graph, and ask them what they think the two lines stand for. (The solid line represents average female math achievement; the dashed line represents average male achievement.) Ask students to discuss why girls achieve higher levels in elementary school, but around the junior high years typically begin to lag in math achievement as compared with boys. This should lead to a discussion of sex-role expectations and so forth. Make sure *you* have read the material on adolescent conflict in Skolnick et al. before leading this discussion. Help students see how lowered mathematical enrollment leads to lower paying jobs in the future.

Explain that this graph is not accurately drawn to scale and is meant to represent what has *typically* happened to girls and boys in the past. It is not necessarily a predictor of the future. Ask students to draw their own graphs for their class and discuss.

Resources

American Statistical Association. n.d. *Careers in statistics and Statistics as a career: Women at work.* Pamphlets. Washington, DC: American Statistical Association.

In these pamphlets, career opportunities in statistics are described, and statistics careers for women are highlighted.

Askew, J. 1982. *The sky's the limit in math-related careers.* Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

This interesting book describes contemporary women in highly math-related occupations. Each of the chapters—on computers, engineering, finance, math education, research mathematics, and statistics—includes several pictures and quotes from women about their jobs and the satisfaction they receive from them. Content is suitable for upper elementary, junior high, and high school students.

Burns, M. 1975. *The I hate mathematics book.* Boston: Little, Brown.

For those students who "seemingly" hate mathematics, this book provides many relevant activities to boost confidence and aspirations. Positive attitudes toward mathematics develop as students experiment with and investigate the uses of mathematics in solving everyday problems. The activities are presented in a way that encourages students to have fun with mathematics.

Casualty Actuarial Society. n.d. *The actuarial profession.* Pamphlet. New York: Casualty Actuarial Society.

A pamphlet describing career opportunities for actuaries.

Equal Employment and Affirmative Action Office. 1987. *Why take more math?* Brochure. Seattle: University of Washington.

This interesting brochure includes reasons for selecting math courses in high school and math requirements for various college majors Although specifically written for the University of Washington, the information applies to most colleges.

Fraser, S., ed. 1982. *SPACES. Solving problems of access to careers in engineering and science.* Berkeley: University of California, Lawrence Hall of Science.

A collection of thirty-two classroom activities designed to stimulate students' thinking about math-related careers, develop problem-solving skills, and promote positive attitudes toward math. Activities are desgned for studens in grades 4–10.

Kenschaft, P. 1986. *Careers for women in mathematics.* Brochure. Wellesley, MA: Association for Women in Mathematics.

This brochure describes the types of careers available in mathematics and the amounts of high school and college math required for them. It also discusses discrimination against women in mathematics-related careers, suggests strategies for dealing with such discrimination, and n nts statistics on women in mathematics. Several other pamphlets and brochures on mathematical careers are referenced in this brochure.

Mathematical Association of America. n.d. *Careers in mathematics.* Pamphlet. Washington, DC: Mathematical Association of America.

This pamphlet contains an extensive list of references pertaining to mathematics and mathematics-related employment. Although the pamphlet is slanted toward high school students, it presents information that should be made available to all junior high students.

Mathematical Association of America. n.d. *The math in high school you'll need for college*. Pamphlet. Washington, DC: Mathematical Association of America.

This interesting pamphlet includes information on the content of high school math courses and a list of college majors with the number of years of high school math needed for each. Although the pamphlet is slanted towards high school students, it presents information that should be made available to all junior high students.

Mathematical Association of America. n.d. *You will need math*. Pamphlet. Washington, DC: Mathematical Association of America.

This pamphlet discusses the reasons that students will need math and lists the amount of high school and college math required for jobs in many different fields. Although the pamphlet is slanted toward high school students, it presents information that should be made available to all junior high students.

Mitchell, J. S. 1982. *I can be anything: A career book for women*. New York: College Entrance Examination Board.

This book provides specific information on a number of math, science, technical, and nontraditional blue collar jobs. Each entry includes a description of the work, educational requirements, information about women in the field, economic outlook, and sources of additional information.

National Council of Teachers of Mathematics. n.d. *Mathematics teaching as a career*. Pamphlet. Reston, VA: National Council of Teachers of Mathematics.

This pamphlet describes career opportunities in mathematics education.

Osen, L. M. 1974. *Women in mathematics*. Cambridge: MIT Press.

This book was written to give students a historical perspective about women in math. Many myths about women in math are exposed, and women's aspirations for mathematical careers are encouraged.

Perl, T. H. 1978. *Math equals: Biographies of women mathematicians and related activities*. Menlo Park, CA: Addison-Wesley.

Math equals is a teacher resource on the history of women in math and science. The book contains biographies of the lives and work of nine famous women, plus interesting math activities related to the area of mathematics in which each of the women worked.

Skolnick, J.; Langbort, C.; and Day, L. 1982. *How to encourage girls in math and science: Strategies for parents and educators*. Palo Alto, CA: Dale Seymour Publications.

This excellent resource examines the effect of sex-role socialization on girls' math/science skills and confidence. It explains how attitudes, parenting and teaching practices, stereotypical play activities and books, peer pressure, and career and family expectations cause girls to question their abilities in math and science, and thus hinder their development in these areas.

In addition to a summary of the socialization process, this book contains a variety of compensatory educational strategies and activities that may be used to encourage females in mathematics. These particularly focus on increasing math confidence, spatial visualization skills, and problem solving and are designed for primary through junior high school students. Both parents and educators can benefit from this book.

Society for Industrial and Applied Mathematics. n.d. *Careers in applied mathematics* and *Profiles in applied mathematics*. Pamphlets. Philadelphia: Society for Industrial and Applied Mathematics.

In these pamphlets, career opportunities in applied mathematics are described, and selected employer in the field are profiled.

Changing Detrimental Attribution Patterns

The term "attribution patterns" refers to the causes to which students attribute their successes and failures in various life situations. Typically, boys are more likely than girls to attribute their successes to their own abilities, whe girls are more likely to attribute their successes to luck, ease of the task, or an o side influence such as a teacher. When accounting for their failures, boys tend to blame their own lack of effort or the difficulty of the task; girls are more likely to attribute failure to their own lack of ability. This attribution pattern occurs even when the abilities and achievement levels of boys and girls are equal. It occurs in many life situations and is particularly debilitating for girls in the area of mathematics. If students believe they are capable of learning or succeeding in a task, but fail because of their choice to expend less effort than necessary, they may be encouraged to try harder and they will persist. But, if students believe that their failure is evidence of lack of ability, they will be more likely to give up. Attributing success to external factors and failure to lack of ability has been linked to a pattern of behavior called "learned helplessness." In this pattern, failure is viewed as inevitable and insurmountable.

- By fifth grade, girls are more likely than boys to attribute poor performance in achievement situations to lack of ability rather than to lack of effort; girls are also more likely than boys to show decreased persistence or impaired performance after failure. (Dweck and Gilliard; Nicholls; both cited in Russo 1985)

- Females are more likely than males to display learned helplessness. (Dweck et al. 1978)

- High math-achieving girls are more likely than any other group of students to attribute their failures to lack of ability. (Wolleat et al. 1980)

- Teachers were found to reinforce typical male/female attribution patterns by being eight times more likely to attribute a boys' failure to insufficient effort than they were a girls'. (Licht and Dweck 1983)

- Both mothers and fathers of boys demonstrated typical male attribution patterns in reference to their sons' math performance; parents of girls demonstrated typical female patterns in reference to their daughters' math performance. (Franklin and Wong 1987)

When children need help, both parents and teachers seem to give boys the message that they have the ability; they just need to put forth more effort. For girls, the message is often that they don't have the ability; less is expected of them. Attribution patterns are highly related to increased confidence and to raised aspirations. Strategies, activities, and resources are presented on the following pages to help you change girls' detrimental attribution patterns.

Strategies

1. Girls who make disparaging comments about their own abilities (even in times of frustration) should be corrected with a positive comment from the teacher. When they know the teacher feels that they *do* have the ability, girls sometimes become more interested in their own progress. Everyone needs someone to believe she or he is capable.

2. Encouragement and compliments must be specific to be effective, and it is best to praise girls for their *ability* (being capable of solving a problem or doing the work)—*not just for their effort.* Don't say, "That's okay, you tried."

3. Effort definitely needs to be encouraged in girls, particularly when they are failing at a task. Stress a "you can do it" attitude for students. Encourage girls to try again and not give up. Stress trying new approaches rather than just "trying harder." Also, stress the old "practice makes perfect" idea.

4. When girls are inclined to dismiss their failure in math because of their parents' past failures ("My mother is no good at math"), it may help to remind them that there is no gene for math ability.

5. Encourage students to talk with each other about their feelings toward success and failure. This may help them see that others attribute their successes to intellectual abilities, not "luck" or circumstances. Small-group activities provide excellent opportunities for minimizing self-consciousness about receiving praise from others.

6. Sometimes it can be very helpful to students for their teachers to model failure-persistence-success behavior. Let students know that you sometimes have trouble figuring out a problem; that you have to work hard at it and try new approaches; and that you know if you keep working on it, you will finally find the solution. Model the idea that making mistakes or getting things wrong doesn't mean that we are "dumb," but that we can learn from our errors. Especially if you are a female teacher, let students know that you're a person who has learned to like math and who knows she has the ability to succeed in it.

Activity

Math Attributions

Objective

To focus students' awareness on the causes to which they attribute success and failure; to help them learn to attribute girls' successes to ability and failures to other causes

Grade Level

Grades 6–9

Time

15–20 minutes

Materials

Discussion stories below

Procedure

Read each of the brief stories below to the class. After reading each story, ask students the questions listed. Discuss how our abilities combined with effort can lead to success and that failure is *not* necessarily caused by *lack of ability*—all of us have ability Make sure that girls, particularly, understand these concepts.

Mary Ann got a very good grade on her math test. When Sue asked her how she got such a high score, Mary Ann said, "I was just lucky."

1. Do you agree?
2. Why or why not?
3. Why do you think Mary Ann did so well on the test?

Encourage your students, especially the girls, to acknowledge that Mary Ann is smart in math—that she has good math ability. They may also come up with reasons that have to do with effort—e.g., she studied a lot—or with receiving extra help from parents or teachers. Make sure your students understand that a high math score definitely indicates ability, although it also requires effort.

Jessica is not doing very well in math; she's having trouble with fractions. She says, "I'll never be able to learn fractions; I just can't understand them. I might as well just give up on them."

1. Do you agree that she should give up?
2. Why or why not?
3. Why do you think Jessica is having a problem with fractions?
4. What do you think she can do about this problem?

Sometimes changing the words we use help change our feelings about something. Encourage your students to look at poor performance in an area of math as "having difficulty" rather than "can't do it." Help them see that if Jessica keeps on trying (expends effort and persists) and gets more help that allows her to *try another approach*, she will be able to understand and use fractions.

> Debra used to like math and do very well in it. But now she doesn't do her math homework, and her grades have started going down. She says, "I guess these low grades mean I'm just not good at math."
>
> 1. Do you agree?
> 2. Why or why not?
> 3. What can Debra do to bring up her grades?

Help your students see that Debra does have the ability to be good at math (she used to do well), and that she just needs to study more.

> Nancy studied very hard for the big test in math, and she got the highest score in her class. Her friend Jean said, "Nancy, you're really good in math." But Nancy said, "No, I'm not very good in math, I just study very very hard."
>
> 1. Do you agree that studying is the only reason Nancy did so well on the test?
> 2. What could Nancy have said instead?
> 3. What would you have said if you were Nancy?

Variation

Substitute male names in these stories and compare students' reactions to the same stories with female names. *Note:* To give this a more thorough test, alternate girl-boy-boy-girl names, then repeat boy-girl-girl-boy names, rather than using all female, then all male names. You may see that your students—both girls and boys—have less trouble acknowledging math ability in a male than in a female.

The activity on the following page, "Finding Real-World Examples," would be a good follow-up to this activity.

Activity

Finding Real-World Examples

Objective

To increase students' awareness of typical male and female attribution patterns; to focus on changing these patterns for girls. (This activity would be a good follow-up to the previous activity "Math Attributions.")

Grade Level

Grades 6–9

Math Concepts/Skills

Using statistics

Time

Part 1—20 minutes; Part 2—variable; Part 3—25 minutes

Materials

Chalkboard, large sheets of butcher paper, examples brought in by students

Procedure

Part 1. As an introduction to this activity, read and discuss the following material with students:

> Researchers have found that when we think about and try to explain why we were successful at something, we usually come up with four different types of explanations: (1) our ability; (2) the work or effort we put in; (3) something in our environment—help or assistance from some other person, special equipment or material, or luck; or (4) that the task was really not difficult, and that's why we did so well. Sometimes people just give one main reason; sometimes they use a combination of reasons.
>
> For example, if someone got a very high grade on their math test, they might explain it by saying that (1) they were smart in math (that is, they had good math ability) or (2) they had studied very hard for the test (effort) or (3) that the teacher's explanation and review had helped (environment) or (4) that the items on the test were really easy ones (task).
>
> People often use the same four reasons to explain their failures. They may blame (1) their lack of ability ("I'm just no good at math"); (2) their lack of effort ("I didn't study enough"); (3) the environment ("I couldn't concentrate because it was too noisy"); or (4) the task ("The material was just too difficult"). Researchers call these reasons "attributions"; that is, these are the reasons to which we attribute success or failure.

Make a chart on butcher paper with the following headings (leave plenty of room under each heading):

Reasons for Success (Attributions)				*Reasons for Failure (Attributions)*			
Ability	*Effort*	*Environment*	*Task*	*Ability*	*Effort*	*Environment*	*Task*
____	____	____	____	____	____	____	____
____	____	____	____	____	____	____	____

Tape the butcher paper to the board.

Help students list some ways that people could express each of these reasons in failure and success situations. For example, under "Environment" in the success column you might list:

"I'm just lucky."
"My parents got me a computer."
"I got extra tutoring."
"My teacher was very helpful."

Save these lists for the "Practicing Attributions" activity that follows this activity.

Part 2. Ask students to look for and bring to class examples of people using these kinds of reasons to explain successes or failures. They could be explaining winning at sports, succeeding in business or a career, or any other types of successes or failures. Students could find the examples on TV, in books or articles about people, in movies, or in real life (no names!). Ask students to write a summary of what was said and the sex of the person saying it.

This outside activity can be assigned over a weekend or over a longer period of time.

Part 3. On the board, tally students' examples separately for males and females using each attribution. What conclusions can be drawn? Did the girls and women tend to use different attributions than the boys and men in students' examples?

Explain to students that, *typically,* females have a more difficult time attributing their successes to their own ability. Instead, they use effort, luck, or help from others as the reasons they did well. Males are *typically* more likely to admit that they were successful because of their ability. Females are more likely to think that their lack of ability caused them to fail, while males often are more likely to think that their lack of effort or work, being unlucky, or difficulty of the task were the reasons they failed.

Discuss how sometimes what we say affects how we feel.

Discussion questions:

1. What happens when I say I don't have the ability or can't do something (for example, "I'll never learn math")? How do I feel?

2. What happens when I say I failed because I didn't study enough (for example, "I could do better if I . . .")? How do I feel then?

3. What happens when I say, "I did well because I was just lucky" or ". . . because someone helped me"? How do I feel?

4. What happens when I say, "I did well because I'm a capable person"? How do I feel?

Students natural reactions to these situations would be the following: in case 1, they would feel like giving up, since there's no point in trying; in case 2, they would feel more like persisting, since they know they can succeed if they do things differently; in case 3, they would feel incapable of functioning on their own, and not take personal credit for their success; and in case 4, they would feel good about themselves and their abilities.

Variation

Make a blank copy of the "Reasons for Success" and "Reasons for Failure" chart, and give one to each student. Have them keep the sheet, and at specific times in class (when homework is graded, after a test, after learning a concept, etc.), have them think about how they did, and then tally the reason(s) for their success or failure.

Activity

Practicing Attributions

Objective
To help students practice positive attributions

Grade Level
Grades 6–9

Time
Variable

Materials
Examples of attributional statements from the previous "Finding Real-World Examples" activity

Procedure
Allow each student to practice aloud using ability attributions for success situations and using effort or environment attributions for failure situations. In the latter case, make sure they're not just "making excuses," but really trying to come up with valid reasons that they can do something about. Some of your female students may find it very difficult to say aloud," I did well because I'm good at ___________." Be sure they overcome any reluctance to use these types of words through practice.

Announce to the class that if they hear any of their classmates using a nonpositive attribution (i.e., attributing failure to lack of ability or success to outside influences), they should insist that the student correct her or his statement to a more positive attribution. You can do the same, concentrating especially on correcting the girls, so that they break negative patterns of speech.

Resources

Sargent, A. G., ed. 1985. *Beyond sex roles.* 2d ed. St. Paul, MN: West.
Exercises and information in this book may be used by individual readers or groups to become aware of the sources, scope, and magnitude of female/male sex roles. This book contains an excellent discussion of the ways sex roles are learned and reinforced by society. The chapter by Russo on the sex-role socialization process provides particularly good background information.

Stereotyping and Mathematics

Stereotyping means making generalizations about people or things based on commonly held beliefs or societal expectations rather than on actual individual characteristics. For example, we are using gender stereotypes when we believe that boys are "supposed to be aggressive" or that girls are "supposed to be quiet." Another common gender stereotype is the belief that boys have greater mathematical ability than girls. Some people also stereotype mathematics as a "masculine" subject and mathematicians as cold, unfeeling, unfeminine persons.

We are taught stereotypes by our parents, the media, textbooks, peers, and teachers. As girls reach adolescence, the stereotype about femininity and mathematics is one of the important barriers that prevent them from forming positive attitudes toward math. One manifestation of this can be seen in high school-age girls who achieve well in math, but have low self-concepts and perceive themselves as being very unpopular. According to Fennema and Ayer (1984), when young girls believe that mathematics is inappropriate for them or their sex roles (i.e., not feminine), they feel anxious about succeeding in math and have more negative attitudes toward it. Male peer pressure is also an extremely important factor for adolescent girls.

- Occupational and subject-related stereotypes are well developed in children by grade three. (Hughes et al. 1985)

- Early in their school years, children learn that mathematics is closely identified with the male role. These stereotypes increase with age and become particularly debilitating for females' math achievement (Sheridan and Fizdale 1981); there is a strong negative relationship between the degree of stereotyping and female math achievement. (Boswell and Katz 1980)

- There is a negative relationship between high math achievement and self-image in sixth and seventh grade girls (Roberts et al. 1987); high school girls who were high math achievers rated their popularity extremely low as compared with popularity ratings of high math-achieving boys and with those of girls who were high verbal/low math achievers. (Franklin and Wong 1987)

- Girls who took four years of theoretical math exhibited more conflict between sex roles and achievement than did cognitively equated girls who enrolled in fewer math courses. (Sherman 1982)

- The majority of female Ph.D.'s in mathematics believe that their field is stereotyped by other persons as masculine. (Boswell 1985)

- High school-age boys and their parents are significantly more likely than girls and their parents to feel that math is more appropriate for males and that males' math skills are superior to those of females (Visser 1986; Franklin and Wong 1987); high school students classify mathematics as a "male" achievement domain. (Stage et al. 1985)

- Female college students are much less likely than males to select math-related majors. (Boli et al. 1984)

- When asked why more young women do not pursue mathematics-related careers, "fear of masculine disapproval" is often given by parents as a reason. (Franklin and Wong 1987)

- Mathematically gifted girls are very reluctant to skip a grade or to enroll early in college math courses for fear of male peer rejection. Girls who take advanced placement courses in math stress the importance of girl friends' support in helping them deal with the disapproval of boys. (Fox 1981)

Northam (1986) studied a number of math books for ages 3-13 that were published in England between 1970 and 1978. In these books, mathematical and scientific skills became increasingly defined as masculine as pupils moved through middle and junior high school. Women and girls almost disappeared in books for ages 12 and 13. In problems, boys a' ' men were typically described in active terms—they were solving problems, explaining to others, devising, planning, performing, and competing. Girls were typically shown repeating or elaborating on a process already learned—cooperating or helping, and correcting another's behavior.

Students' needs to establish their masculinity or femininity become extremely important during the adolescent years. If, at that time, girls see mathematics as a "masculine" subject, and if they perceive the world of mathematics as a male-dominated place in which they do not belong, girls will begin to make educational and career decisions that exclude math.

Since gender and math stereotypes appear to develop during the early elementary years, it is critical that we begin to intervene during those years and during the junior high years to offer some alternative views for girls. It is particularly important that we also target our intervention efforts toward boys, as well as girls, because boys tend to hold more stereotypical attitudes, and because negative male peer pressure can be a very powerful deterrent to adolescent girls' positive math attitudes. The strategies, activities, and resources described on the following pages are designed to change these stereotypical attitudes.

Strategies

1. Word problems in which women are depicted as technical career persons functioning at the center of problems can go a long way toward reducing stereotypes. Be sure your math text contains many such examples. If it does not, you can supplement it with your own problems.

2. Statistics that chronicle the low percentage of women graduates in math-related fields such as engineering, the lower pay for women, and so on can serve as springboards for discussion about the unfairness of stereotyping in language and social assumptions. These statistics are often available through local school counselors, as well as state and regional sex equity centers. Your state department of education will probably have a sex equity coordinator who will be able to give you the address of the nearest equity resource center and/or provide you with resources.

3. The spoken language is an extremely powerful tool in building and reinforcing, or tearing down, stereotypes. Be sure that you are not using the generic "he" when referring to students, principals, doctors, etc. Also, don't use the generic "she" when referring to other teachers, nurses, or parents.

4. Just as math-related activities need to be specifically targeted toward a female audience, males must be allowed and encouraged to consider female-dominated areas of activity. Whenever possible, display your lack of sex bias by discussing home economics and theater (or other subjects), with boys in mind.

5. For open house night or in a newsletter, prepare a brief pitch to parents to help them become more aware of how their incidental stereotypical remarks about math and women may be damaging their daughters' math potential. Remind parents that "Attitudes are contagious—is yours worth catching?"

Activity

Who Should?

Objective To generate awareness among students of their own sex-role biases, and to provide them with a framework for becoming open to seeing both sexes in diverse roles

Grade Level Grades 6–9

Math Concepts/Skills Using statistics, calculating percentages

Time 15 minutes for the questionnaire, plus 10–20 minutes discussion time

Materials "Who Should" worksheet on the following pages

Procedure See instructions on the worksheet. Use this questionnaire, or any of its sections, to determine the extent of sex-role stereotyping evidenced by your students. As a math exercise, have students tally results and make a table of percentages of male and female students who selected each alternative. Use the results as a springboard for discussion in areas where the class openly disagrees.

Variation Ask other teachers to give the questionnaire to students in their classes or offer it for all students via the school newspaper. Have your students complete a school survey of student attitudes and analyze the data with statistics. The list of careers used on the "Who Should" sheet can be expanded to include any of those listed below. Also, see Meer (1982) *Sex role stereotyping in occupational choices: A career counseling manual* (page 10) for an expanded list of careers and other stereotype awareness experiences and activities.

Cook	Chef	Florist
Fashion designer	Nurse	Artist
Baker	Architect	Carpenter
Doctor	Airline attendant	Poet
Engineer	Police officer	Chemist
Teacher	Dentist	Lifeguard
Librarian	Fire fighter	Bricklayer
Car dealer	Pilot	Plumber
Secretary	Newspaper reporter	Dancer
Store owner	Welder	Chauffeur
Disc jockey	Babysitter	Housekeeper
Bookkeeper	Judge	Factory worker
Pharmacist	Telephone operator	Bus driver
Butcher	Accountant	Musician
Principal	Athlete	TV newscaster
Interior decorator	Auto mechanic	Banker
Travel agent	Truck driver	

Worksheet

Who Should

Student Information

1. Please circle your gender: Girl Boy
2. Please circle your grade: 6 7 8 9

PART I. For each of the jobs listed below, circle "Man" if you think only a man should do the job; circle "Woman" if you think only a woman should do the job; circle "Both" if you think both men or women should do the job. Be sure to circle only *one* answer for each job.

3. Airplane pilot	Man	Woman	Both
4. Artist	Man	Woman	Both
5. Astronaut	Man	Woman	Both
6. Carpenter	Man	Woman	Both
7. Cook	Man	Woman	Both
8. Doctor	Man	Woman	Both
9. Engineer	Man	Woman	Both
10. Forest ranger	Man	Woman	Both
11. Lawyer	Man	Woman	Both
12. Librarian	Man	Woman	Both
13. Nurse	Man	Woman	Both
14. President of the United States	Man	Woman	Both
15. Secretary	Man	Woman	Both
16. Scientist	Man	Woman	Both
17. Store clerk	Man	Woman	Both
18. First grade teacher	Man	Woman	Both
19. Telephone operator	Man	Woman	Both
20. Truck driver	Man	Woman	Both
21. High school math teacher	Man	Woman	Both

PART II. For the school work and activities listed below, circle "Girl" if you think only a girl should do this; circle "Boy" if you think only a boy should do this; circle "Both" if you think both girls or boys should do this. Be sure to circle only *one* answer for each activity.

22. Solve difficult math problems	Girl	Boy	Both
23. Learn to program computers	Girl	Boy	Both
24. Take advanced math classes in high school	Girl	Boy	Both
25. Play games on a computer	Girl	Boy	Both
26. Read poems	Girl	Boy	Both
27. Read lots of stories and books	Girl	Boy	Both
28. Write funny stories	Girl	Boy	Both
29. Learn a foreign language	Girl	Boy	Both

PART III. When there are class jobs to be done, who do you think should do them? Circle "Boy" if you think only a boy should do them; circle "Girl" if you think only a girl should do them; circle "Both" if you think both girls or boys should do them. Be sure to circle only *one* answer for each activity.

30. Messenger	Boy	Girl	Both
31. Class president	Boy	Girl	Both
32. Eraser cleaner	Boy	Girl	Both
33. Check out game equipment	Boy	Girl	Both
34. Class secretary	Boy	Girl	Both
35. Water the plants	Boy	Girl	Both

PART IV. Here is a list of spare time activities. Circle who should do them: a woman, a man, or both.

36. Play football	Woman	Man	Both
37. Swim	Woman	Man	Both
38. Play the violin	Woman	Man	Both
39. Go to sports events (like baseball)	Woman	Man	Both
40. Gymnastics	Woman	Man	Both
41. Help in a hospital every week	Woman	Man	Both

Activity

Textbook Awareness

Objective

To make students aware of potential and sometimes very subtle bias in math textbooks; to stress an appreciation for the changing and evolving roles of women in professional areas

Grade Level

Grades 6–9

Math Concepts/Skills

Calculating averages, comparing data

Time

One class period

Materials

Large piece of butcher paper, math books from the 1960s and 1970s (Womany schools store these in an old book room, but if yours does not, you may find old copies in the library.)

Procedure

The purpose of this activity is not to "put down" traditional roles but to stress the need for expanded options and choices for both men and women.

Outline a tally sheet on the butcher paper as shown below.

Book title ______________________

Women or Girls in Traditional Roles	*Women or Girls in Nontraditional Roles*
________	________
________	________
________	________
________	________

Make a similar tally sheet for men or boys in traditional or nontraditional roles.

Book title ______________________

Men or Boys in Traditional Roles	*Men or Boys in Nontraditional Roles*
________	________
________	________
________	________
________	________

Divide the class into random groups of three students. Half the groups will use their own books (from math class); the other half will use the vintage texts. You may want to examine some copies in advance to make sure there is actually variation between the books that students can identify. Try to have the groups using vintage texts use the same one.

Discuss the traditional roles of women and men versus today's roles. Each group will review their books to spot traditional or nontraditional roles for females and males in the story problems, pictures, or supplementary materials. Note that examples of traditional roles for women could involve traditional occupations such as teacher, nurse, housewife, and so on, or they could involve the use of passive versus active roles, such as the assistant or the person who needs help versus the woman as a problem solver. Traditional roles for men could include scientist, engineer, professional, and/or the active problem solver in story problems. Students can write the names of the women and men along with the page numbers on their tally sheets.

Have students tally the number of women and men found in traditional and nontraditional roles and figure averages—mean, median, and mode—for each text. Compare the findings for current and older texts in a class discussion. Let students read some examples and comment on positive changes. Encourage students to discuss how the use of men's and women's names in problems can subtly give the message that females can or cannot do math problems. Let students suggest ways of rewriting problems to eliminate sex bias.

Note: If, in your survey, you and your students discover that your current math text reveals stereotyping and bias in the way females are depicted in problems, have students rewrite the problems to correct this bias, and talk to your textbook committee.

Activity

Images in Advertising

Objective

To increase student awareness of male and female images as presented in advertising

Grade Level

Grades 6–9

Math Concepts/Skills

Calculating averages, comparing data

Time

30–60 minutes outside of class; 30 minutes in class

Materials

Twelve assorted magazines, including three news magazines such as *Life, U.S. News and World Report,* and *Time;* three traditionally "men's" magazines such as *Outdoor Life, Sports Illustrated,* and *Popular Mechanics;* three traditionally "women's" magazines such as *Seventeen, Glamour,* and *Better Homes and Gardens;* and three "new women's" magazines such as *Working Woman, Ms.,* and *Self;* tally sheets

Procedure

The purpose of this exercise is not to "put down" traditional roles, but to make students aware of their choices and options.

Make tally sheets similar to those used for the previous "Textbook Awareness" activity Divide the class into 12 small groups, and ask each group to go through one magazine and tally the number of men and women in traditional and nontraditional careers in ads. Traditional careers for men would be indicated by business suits, lab coats, hard hats, etc. Examples of nontraditional careers would include men as secretaries, nurses, teachers, or reporting to a female boss. Examples of women in traditional careers would include teachers, nurses, housewives, maids, secretaries, waitresses, and low-level factory workers. Examples of nontraditional careers would include women as scientists, business persons, engineers, pilots, bosses, etc.

After students have tallied their results, have them compare each of the four types of magazines by looking at the average number of males and females pictured in each category in each group of magazines.

Discuss how the sex roles presented in advertising help form our attitudes about expected roles and careers for males and females. Help students challenge the assumptions and stereotypes depicted in advertising.

Variations

1. Students can complete this activity with a survey of TV advertising. Have them compare the images of men and women shown on ads associated with different types of programs—news, football, soaps, or general interest shows.

2. As a joint activity with a history teacher, students can do a comparative study of 50–75-year-old magazines to see how the roles of men and women have changed.

Activity

Stereotypes in the Media

Objective

To focus students' awareness on the messages we receive about sex roles from the media

Grade Level

Grades 6–9

Time

Variable

Materials

Magazines, newspapers, TV shows, movies

Procedure

The media is known to contribute significantly to our learning of sex roles by reflecting and reinforcing popular stereotypes. In a content analysis of Australian articles (Leder 1986) on individuals who were singled out for their achievement in any field other than sports, three common themes recurred: (a) females need to work harder than males to achieve their goals; (b) females have to balance success and interpersonal/family relationships (this is not emphasized as a requirement for males); and (c) success somehow "happened" to the females, it was not expected or sought after.

Discuss this study with your students. Are these realistic ideas, or are they erroneous? How could the first theme inhibit girls from being high achievers? Is it really true that women need to work harder? Do women have to balance success with relationships more than men do? Why or why not? Do you think success for women "just happens?" Link discussion on this with the material on attribution processes in the previous section of this guide. Ask students to look for evidence of media stereotyping (in magazine articles, TV, movies), and also have them try to find media examples that contradict these stereotypes. Discuss with students how the things we learn from the media can shape and reinforce our own attitudes either positively or negatively and can lead to erroneous or correct conclusions.

Resources

American Institutes for Research. 1980. *Programs to combat stereotyping in career choice.* Palo Alto, CA: American Institutes for Research.

In this book, sex stereotyping in career choice is discussed, and nine programs designed to expand students' career awareness and break stereotypical patterns are described. Most of the programs are suitable for junior high students.

Campbell, P. B., and Katrin, S. E. 1978. *Sex stereotyping in math doesn't add up.* Groton Ridge Heights, Groton, MA.

This unit on sex stereotyping and its effect on math education includes instructions, a 25-minute audiotape, four transparency masters, two handouts, and a bibliography. Topics covered include stereotyping, math word problems, sex differences in math skills, and math courses and job choices. The materials are suitable for junior high students, and the unit, with activities, takes between one and two hours to complete.

Council on Interracial Books for Children. 1984. *10 quick ways to analyze children's books for racism and sexism.* NY: Council on Interracial Books for Children.

This one-page flier gives parents and educators ten guidelines for evaluating children's books for racist and sexist attitudes. The guidelines would also be appropriate for evaluating junior high materials.

Fraser, S., ed. 1982. *SPACES: Solving problems of access to careers in engineering and science.* Berkeley: University of California, Lawrence Hall of Science.

A collection of thirty-two classroom activities designed to stimulate students' thinking about math-related careers, develop problem-solving skills, and promote positive attitudes toward math. Activities are designed for students in grades 4–10.

Gordon, R. 1981. *Peer report—ties that bind: The price of pursuing the male mystique.* Washington, DC: NOW Legal Defense and Education Fund.

An excellent summary of the negative effects of sex-role stereotyping on men and boys. The material in this publication provides interesting discussion topics about stereotyping for students.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. The purpose of the program is ultimately to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes sections with activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction.

Meer, C. 1982. *Sex role stereotyping in occupational choices: A career counseling manual.* Rutgers: State University of New Jersey, Institute of Management and Labor Relations.

This manual includes background information on women and the work force and provides a number of exercises to promote awareness of nontraditional career options for students. Although primarily designed for senior high school students, the materials may also be used with junior high and college students.

Skolnick, J.; Langbort, C.; and Day, L. 1982. *How to encourage girls in math and science: Strategies for parents and educators.* Palo Alto, CA: Dale Seymour Publications.

This excellent resource examines the effect of sex-role socialization on girls' math/science skills and confidence. It explains how attitudes, parenting and teaching practices, stereotypical play activities and books, peer pressure, and career and family expectations cause girls to question their abilities in math and science, and thus hinder their development in these areas.

In addition to a summary of the socialization process, this book contains a variety of compensatory educational strategies and activities that may be used to encourage females in mathematics. These particularly focus on increasing math confidence, spatial visualization skills, and problem solving and are designed for primary through junior high school students. Both parents and educators can benefit from this book.

Part 2

Math Relevance

This section of the guide contains suggestions that will

1. help you increase students' interest in math
2. help students see the relevancy of math in their everyday lives and its usefulness for their future careers
3. provide information on math-related careers
4. provide positive role models for girls

Increasing Interest in Mathematics

Children in the early elementary grades like mathematics and exhibit a fairly high degree of interest in it. However, as they move through junior high and high school their liking for and interest in math decrease dramatically. This trend is especially true for girls.

- Girls often find math less interesting than do boys. (Fox 1981)
- Girls' low math interest is one of the most important factors in explaining gender differences in mathematics involvement. (Stage et al. 1985)
- Liking for math is related to decisions to enroll in elective math courses; the relationship becomes stronger as students progress through high school. (Armstrong 1985)
- Between sixth and twelfth grades, liking for mathematics declines dramatically for both boys and girls. (Brush 1985)

To make math more interesting for girls, some researchers have suggested stressing its practical rather than abstract and theoretical aspects. Others have suggested introducing more people-oriented problems that deal with real-world situations. We also need to try, as much as possible, to make the math-learning process fun for all students. It is important that junior high math teachers try to build on students' early liking for and interest in math. The suggestions on the following pages will help you do this.

Strategies

1. To make even drill and practice fun, divide students into teams, which can be both cooperative and competitive (group-to-group) for students. Besides drill-and-practice exercises, students can also work in teams to solve puzzles and problems. See the section on cooperative learning for more information on group activities.

2. To stress the practical aspects of mathematics, integrate math as much as possible across the curriculum. In language arts class, children can read biographies of women who were successful mathematicians or scientists. In discussing these biographies, emphasize the determination and successes of the women.

   Math has many applications in social studies. For example, when studying another country, students can determine its square miles and compare that figure to their own state or to the United States. They can figure ratios based on this information. They can also construct graphs of the areas in square miles or compare drawings to scale, laying one on top of the other for visual comparison. History presents many opportunities to use math in figuring elapsed time, people's ages, etc.

   Science is probably the subject with the most mathematical applications. Ask other teachers to help make sure students understand how math is useful, in almost all school subjects, in solving problems and finding information. See the section on working with other teachers for more suggestions.

3. To give math or algebra problems a more personal flavor, try substituting your students' names in the word problems. Encourage students to write their own problems and think of ways math is useful for them.

4. In teaching math, use many "fun" activities with teasers and problems that are interesting, but within the intellectual grasp of your students. For many students, problems that are too challenging can lead to the view of math as a frustrating subject.

5. Have students carry out a "math scavenger hunt" either individually, in pairs, or in groups or teams in which students find objects that can typically be measured in feet, inches, miles, fractions, etc. Another possibility is to have students find as many objects of the same shape (for example, triangles or squares) as they can in the classroom.

6. Start a Young Astronaut chapter at your school. Young Astronaut is a national program linking schools to an organization that provides curriculum activity packages, materials, and (on occasion) funds for interesting real-life projects. Each project includes math, science, social studies, and language arts components, and activities that stress elevating math and science skills and interest. Each curriculum package contains teacher instructions for activities suitable for grades one through nine. For more information, write to the Young Astronaut Council, 1211 Connecticut Avenue, NW, Suite 800, Washington, DC 20036.

7. Another good activity is "MATHCOUNTS," an annual nationwide competition for junior high students. Students receive worksheets from the organization with which to practice advanced math skills. Competition for teams of four students are held at local, state, and national levels. MATHCOUNTS is described in more detail in the activities in this section.

Activity

Find a Million

Objective

To help students obtain a visual concept of the size of a million; to develop the place value concepts of how many thousands and hundreds there are in a million; to practice reading and computing large numbers

Grade Level

Grades 6–9

Math Concepts/Skills

Working with whole numbers, place value, constructing graphs

Time

Variable (This activity could take up to two class periods. Time spent on the project will reinforce the immensity of the number.)

Materials

Approximately 130 copies of a sheet with about 8,000 dots on it, or use the sample included with this activity (this sheet has 67 x 120 = 8,040 dots), marking pens

Procedure

Most of us cannot really contemplate the magnitude of very large numbers because we have no sensory reference point. This activity will help students better understand large numbers. Have students determine how many dots there are on one page. Once they have completed this task, ask how many pages it would take to make a million. Using pages like the sample, it will take about 124 1/2 pages (or 125 pages exactly if there were 8,000 dots per page).

Next, have students put the pages on a bulletin board, wall, or floor, until they have 124 1/2 pages or a million dots displayed. Students could also mark off each set of 1,000 dots, 10,000 dots, or 100,000 dots using different colored pens or markers. They can answer questions like "How many 1,000s are there in a million?"

You may also use the dots to show everyday data that need to be expressed in large numbers. For example, you might find the dots to show the population of your community, the number of new cars (Chevrolets) sold last year, etc. Such information can readily be obtained from an almanac or other reference book. Since this project requires so much paper, you may want to laminate the sheets for future use.

In the section of this guide on computer access, there is another "How Big Is a Million" activity. In this one, a computer is programmed to count to one million, and students are asked to observe how long this takes. You might want to conduct these two activities at the same time.

This activity was drawn from *Dr. Jim's elementary math prescriptions* by James Overholt.

Variation

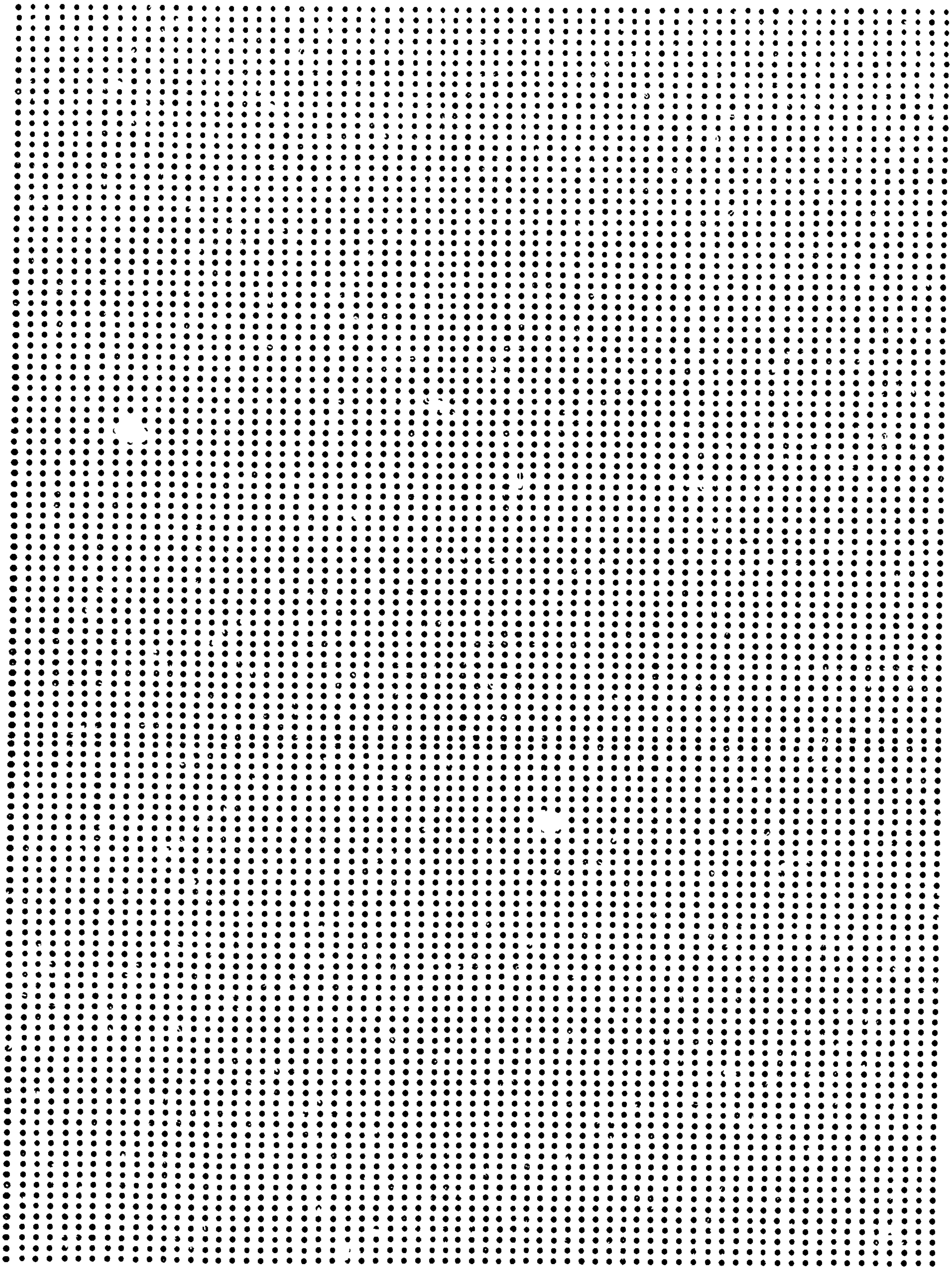
After students have formed a sensory-based concept of the magnitude of one million, they should have a better understanding of even larger numbers—i.e., when you discuss U.S. population, federal budgets, distances to stars, etc. Ask them to think about the fact that 200 million would be as large as 200 sets of the dots displayed on the walls. As another way of visualizing larger numbers, you could let each dot represent 10, 100, or 1,000. Ask students to determine the total numbers of dots displayed in each of these cases.

If you let each dot represent a larger number, you can then ask students to mark off distances, dates, etc. For example. estimated distances from the earth to the moon and from the earth to the sun are approximately 240,000 and 93 million miles, respectively. Have students determine the scale needed to represent these distances (i.e., if each dot represented 100, the entire set would represent 100 million). To visualize these distances, let the earth be at the first dot. Now have students determine which dots would represent the moon and the sun.

According to the U.S. Bureau of the Census (1987), the U.S. population was 240,468,000 in 1986. It is projected to reach 249,657,000 by 1990; 267,955,000 by 2000; and 310,762,000 by 2080. Ask students to use the dots to represent these data.

It is estimated that the earth is 4 1/2 billion years old. Let students select a scale (the values each dot must represent) to depict this data. Then, let them mark off various historic dates, assuming the earth began 4 1/2 billion years ago.

Another way of visualizing these data would be to have students construct bar graphs with appropriate scales to represent these distances.



Activity

The Perfect Room for Me

Objective

To allow students to relate objects to their scale sizes and utilize their skills to add, subtract, and multiply fractions in an activity that has particular significance for them

Grade Level

Grades 6–9

Math Concepts/Skills

Working with fractions, geometry, area, perimeter, and "to scale" measurement

Time

Up to two math periods (could be done as an outside or take-home activity)

Materials

Graph paper, rulers, tape measures, calculators, catalogs

Procedure

Ask students to imagine and design their perfect room. As an introduction to the concept of floor plans, acquaint them with house plans in a limited manner—especially noting the "to scale" measurements that relate to actual space. Draw a floor plan of your classroom—everyone is familiar with this space—and discuss the measurements of objects identified by elements in the drawing.

Have students draw a "to scale" version of their ideal room with furnishings. You might stress either that money and resources are unlimited or require that students follow a realistic budget with limited room size and specific functional room requirements (i.e., the room must have a place to sleep, a place to put clothes, a window, etc.).

In order to simplify the process for your students, establish the scale of measurement most appropriate to the graph paper you've distributed. To determine the sizes of furnishings, students could take measurements at home, or you could use a furniture catalog that gives sizes of objects. Small templates also could be made from initial student measurements. These could be used to trace in "to scale" depictions of an assortment of items students may want in their ideal rooms.

Have students determine the area and perimeter of their rooms.

You may add several other math problems to this assignment—i.e., what would be the total cost (from a catalog) of new furnishings; at $24.99 per square yard, what would be the cost of a new carpet; what would be the cost of paint and/or wallpaper (look up coverage and sizes of rolls in catalog)?

Variations

1. For a more ambitious project, your students can also design their dream houses.
2. Have students make "to scale" templates for various pieces of furniture. Laminate these for future use.

Activity

Math Fun Clubs

Objective

To promote math interest and fun in a positive, nonthreatening atmosphere; to create a schoolwide acceptance of math as an interesting and fun leisure time activity

Grade Level

Grades 6–9

Math Concepts/Skills

Will vary according to club activities

Time

30–40 minutes at regular meetings during lunch period, after school, or on weekends

Materials

Assorted puzzles and math games and TV videotapes (Some suggestions for resources include the following magazines: *Instructor, Mathematics Teacher*, and *Arithmetic Teacher*. Also try these books: *The book of think* and *The I hate mathematics book* by Burns [see resource list]. Television videos of "NOVA," "Square One," and "3-2-1 Contact" can be used.)

Procedure

Stimulate interest in mathematical investigation through exciting topics not usually discussed in the classroom.

Invite interested students to participate in a math fun club during activity time (lunch, after school, before school, etc.). Invite a few interested parents to assist in planning and conducting club activities.

The students can play the math games that they enjoyed during class, but never seem to have enough time to complete. (Pentomino puzzles, perceptual puzzle blocks, or polyhedra dice games may be found in the Creative Publications catalog available from P.O. Box 10328, Palo Alto, CA 94303.)

Have students form teams for math tournaments. Run the activity with playoffs, and issue some type of rewards, or enter a team in a MATHCOUNTS competition (see following activity for details).

Students can sponsor and support the school or community in fund-raising activities, which will promote the math club in a positive manner. Encourage parents to participate in and support the club. Be sure to encourage girls' participation in the club. In fact, if the group becomes sex segregated because only boys choose to join, you may want to form separate clubs for girls and boys.

Publicize the club's activities throughout your school.

Activity

Math Clubs—MATHCOUNTS

Objective

To elevate the prestige associated with achievement in mathematics among seventh and eighth grade students; to increase awareness of the importance of mathematics among parents, educators, and the general public

Grade Level

Grades 7–8

Math Concepts/Skills

Vary according to MATHCOUNTS agenda

Time

Weekly meetings and one Saturday for chapter competition

Materials

MATHCOUNTS handbook

Procedure

MATHCOUNTS is a national program that includes an accelerated coaching program and a series of competitions designed to produce high levels of math achievement in junior high students. The program is sponsored by the National Society of Professional Engineers, CNA Insurance Companies, the National Council of Teachers of Mathematics, and NASA. To obtain copies of the handbook write to: MATHCOUNTS Foundation, 1420 King St., Alexandria, VA 22314, (703) 684–2828.

Invite interested students to participate during activity time (lunch, after school, or scheduled activity time). The handbook contains all the information, rules, and sample rounds needed to sponsor a team to compete within your local chapter. This activity is suitable for only the top math acheiving students in your class or school—be sure to encourage the top girls to participate.

Activity

"Math Facts" Scavenger Hunt

Objective

To increase interest in numbers and mathematics

Grade Level

Grades 6–9

Math Concepts/Skills

Working with whole numbers and fractions

Time

Up to one class period, or use as a "sponge" activity for students who have extra time after completing the class assignment

Materials

Worksheets and calculators, lists of math facts questions for the scavenger hunt (examples of questions are listed below)

Procedure

Pose a problem that your students will have to solve by finding out a number of "facts" they may not already know. Examples of problems are given below.

1. Find the number of windows in our school building; divide by the number of bones in the human body; multiply by the number of states in the United States with the letter T in their names.

2. Take 80% of the number of keys o standard typewriter; add the number of elements; divide by the number of days in a leap year minus 3; multiply by 1/2; subtract the number of counties in your state.

3. Take the number of planets in our solar system; divide by the year Columbus discovered America; multiply by 1/2 of the area code for Washington, D.C.; divide by 25% of the letters in the alphabet.

This activity may be done in teams or by individual students. It is also a good activity for math clubs. The activity can be used to emphasize learning in certain subject areas, such as science, health, geography, and so forth by focusing on problems related to that subject matter. You may want to use this in team teaching with a teacher from another subject area.

Variation

Encourage your students to develop their own problems. (The student who poses the problem must also come up with a correct answer.)

Activity

Planning "Dream" Class Trips

Objective

To give students practice estimating costs, obtaining information, figuring detailed expenses, and planning savings

Grade Level

Grades 7–9

Math Concepts/Skills

Working with whole numbers, estimating, computing interest

Time

Variable—much of this activity can be done outside of class

Materials

AAA guides, travel brochures (obtained by students), calculators

Procedure

First let students discuss and decide on four different "dream" one-week class trips—the places they would most like to visit. Ask each student to think about the *total cost* of each of the four trips, and write down his or her estimate.

Divide students into four approximately equal groups. Using the travel brochures, AAA g des, and other resources (phone calls to the various agencies), have each group determine the total cost of its dream trip. They should include the following costs: hotel and food; airline; car rental; and other transportation, such as bus or train fares. A good place for hotel information is the American Automobile Association, or AAA. Each group should also compile this information on a cost-per-person basis.

Several types of math problems can be used to deal with funding for the trip. Students could develop various plans, including fund-raising events (have them project expenses and gross and net profit) and savings plans. For example, if every student had saved $25.00 per year toward the trip since first grade, and their money had earned an average of 7% interest per year, how much would each have now? (Answer = $256.16) Or, if the trip took place during the last week of June, how much would each student have to save per week between now and that time?

Variations

1. Students could also plan "dream" class parties, "dream" graduation days celebrations, and so on, including costs and fund-raising plans.

2. Another similar activity w . be to have students select their "dream car" with options, find its initial cost, and calculate interest on borrowed money, insurance costs, operating costs, repairs, and depreciation to figure the total per year costs of owning the car for five years.

Resources

Bright, G. W.; Harvey, J. G.; and Wheeler, M. M. 1985. *Journal of Research in Mathematics Education Monograph Number 1: Learning and Mathematics Games.* Reston, VA: National Council of Teachers of Mathematics.

This monograph includes a summary of the authors' research on the cognitive effects of mathematics instructional games, along with a description of nine games. Most of the games are suitable for junior high school students.

Burns, M. 1982. *Math for smarty pants.* Boston: Little, Brown.

This book contains a wide range of accessible activities presented in an entertaining format. It would be particularly useful for expanding students' perceptions of mathematics.

Burns, M. 1976. *The book of think.* Waltham, MA: Little, Brown.

An entertaining book about problem solving. Includes many fun activities that can be used for class or for math clubs.

Burns, M. 1975. *The I hate mathematics book.* Boston: Little, Brown.

For those students who "seemingly" hate mathematics, this book provides many relevant activities to boost confidence and aspirations. Positive attitudes toward mathematics develop as students experiment with and investigate the uses of mathematics in solving everyday problems. The activities are presented in a way that encourages students to have fun with mathematics.

DeRoche, E. F., and Bogenschild, E. G. 1977. *400 group games and activities for teaching math.* West Nyack, NY: Parker.

This book includes 400 classroom-tested math strategies and activities suitable for use in cooperative mathematics learning for elementary and junior high students. The activities are enjoyable and focus on the practical implications of learning math in a cooperative classroom atmosphere.

Downie, D.; Slesnick, T.; and Stenmark, J. K. 1981. *Math for girls and other problem solvers.* Berkeley: University of California, Math/Science Network.

The activities in this book encourage independent thinking and creativity in mathematics. Students and teachers are encouraged to think about problem solving in versatile ways and forms. Although this book was originally designed for females, the activities are appropriate and interesting for both boys and girls, ages 7–14. The book would also be an excellent resource for math clubs.

Fraser, S., ed. 1982. *SPACES: Solving problems of access to careers in engineering and science.* Berkeley: University of California, Lawrence Hall of Science.

A collection of thirty-two classroom activities designed to stimulate students' thinking about math-related careers, develop problem-solving skills, and promote positive attitudes toward math. Activities are designed for students in grades 4–10.

Howard, B. C. 1982. *Mathematics in content areas (MICA): A teacher training approach.* Washington, DC: Office of Education, Teacher Corps.

This resource details an agenda for an in-service program to develop elementary and secondary teachers' mathematical abilities and to help them integrate and teach mathematical concepts across the curriculum. In the secondary model, math teachers identify math skills most appropriate for supporting other subject areas; they increase their abilities to provide instruction in at least one additional subject area through the use of mathematics; and develop skills in consultation, curriculum building, and team teaching. In the second phase of the program, a math teacher works with one or more content area teachers in peer support learning teams.

Massialas, B. 1983. *Fair play: Developing self-concept and decision-making skills in the middle school: Decisions about mathematics (Student guide* and *Implementation handbook).* Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

Decisions about mathematics includes many real-life activities to interest middle school students and to promote math-related careers. Activities are organized around the topics of "math and money," "collecting and analyzing data," and "your future."

Overholt, J. L. 1978. *Dr. Jim's elementary math prescriptions.* Santa Monica, CA: Goodyear.

Dr. Jim's elementary math prescriptions is a resource for educators in grades K–8 who are searching for effective methods of teaching mathematics. Each mathematical concept is presented with alternative methods to accommodate students with varied learning styles, abilities, and interests. Selected activities provide enjoyable mastery practice, so that students will develop mathematical competence and appreciation.

Silvey, L., and Smart, J. R., eds. 1982. *Mathematics for the middle grades 5–9.* Reston, VA: National Council of Teachers of Mathematics.

This book was developed to aid teachers in promoting the mathematical development of students in grades 5–9. The three sections of the book cover critical issues in mathematics education, unique learning activities, and strategies for teaching problem solving.

Smith, S., and Backman, C., eds. 1975. *Games and puzzles for elementary and middle school mathematics: Readings from the* Arithmetic Teacher. Reston, VA: National Council of Teachers of Mathematics.

This book contains more than 100 articles on the use of games and puzzles to capture students' interest and imagination.

Making Math More Relevant and Useful

Many junior high school students do not see how mathematics is relevant to their daily lives or how it will be useful in future careers. The way we teach math does not often emphasize its usefulness to students. Because the utility value of mathematics, as perceived by students, has been found to be a strong predictor of enrollment in elective math courses in high school, it is important that we stress the ways math can be used while we teach math skills.

- Both male and female students who perceived math as useful to them were more likely to persist in its study. (Pedro et al. 1981)
- Perceived usefulness of mathematics is also related to math achievement in high school. (Chipman and Wilson 1985)
- As early as seventh grade, boys rate math as more useful than do girls. (Stage et al. 1985)
- Although gender differences seem to be narrowing, boys still judge mathematics to be more useful for themselves than do girls. (Chipman and Wilson 1985)
- In a study of senior honors English students, very few could think of a way that they currently use mathematics in their daily lives. (Franklin, Mueller, and Blankenship 1987)

The suggestions on the following pages should give you some ideas about how you can introduce more information about math usefulness, while still using class time to teach math skills and concepts.

Strategies

1. Stress real-life problems in math. Search your classroom environment for math-related problems that are relevant to students' immediate lives and needs. For example, figure the percentage of students who choose each leisure activity as their favorite. Determine the average number of writing implements in each desk or the number of minutes available for each student at the computer, given the number of students, computers, and computer time. Or, compute the average number of minutes students spend sleeping, watching television, or at school.

2. Select a group of lunch preference counters who collect data for the class to make graphs of daily and weekly hot lunch eating patterns, and possibly even determine the cafeteria's best meals.

3. When planning class parties, fund raisers, and so on, let the class determine the amounts of ingredients, the costs of items, and the profits.

4. Your local newspaper can provide the basis for many interesting, relevant, and timely math activities. For example, you can use stock quotes on the financial pages as the basis for an activity in which students make "paper investments," track their stocks, make graphs, figure percentage increase or decreases, and so forth. Articles about financial conditions and businesses can serve as the basis for problems about earnings, interest rates, discounts, etc. The sports pages are also full of statistics that can be used as the basis of problems and activities with decimals, fractions, and averages.

5. Another excellent source of interesting data for class projects is the U.S. Bureau of the Census. Your community library should have copies of current reports. The *Census catalog and guide for 1988* includes abstracts and ordering information for reports on topics such as population, transportation, agriculture, and business. There are also census publications that provide state-by-state data.

6. Our math curriculum typically does not encourage students to ask, "What purpose is served by solving these problems?" or "Why are we being asked to learn this?" As much as possible, try to give your students a sense of purpose about each math concept they learn. Show how the math they are learning relates to real-life situations and how people can and do use it.

7. The poster *When are we ever gonna have to use this?* by Saunders is another great resource you can use to help students see the relevance of various math topics. The poster displays a matrix of 61 different math topics by 100 different occupations and is marked to indicate which occupations use each math topic. It is based on research conducted by Saunders, who interviewed people from a variety of occupations to determine the kinds of mathematics they actually use in their work. The poster is available from Dale Seymour Publications, P.O. Box 10888, Palo Alto, CA 94303, order number D501344. In a 1980 article in the *Mathematics Teacher*, Saunders describes the research recommendations for making junior high and high school math more relevant and provides an

excellent sample of word problems specific to various occupations. The article also includes a table listing math topics ranked by percentage of occupations that use these topics.

Activity

Math in My House

Objective

To make students aware of the various ways their family members use mathematics in their daily lives; to help involve parents in their children's math education

Grade Level

Grades 6–9

Math Concepts/Skills

Computing and interpreting statistics, calculating percentages, constructing bar and circle graphs

Time

20–40 minutes (This activity should be partially done at home; in-class time will depend on the level of reporting you require. You might use it as an extra-credit assignment.)

Materials

Graph paper or chalkboard, copies of "Math in My House" worksheet (copy on page 90), calculator

Procedure

Design a tally sheet (or use copies of the sample worksheet that follows) on which students may record their answers. Plan the questions students will ask their parents or other family members about the ways their family members use mathematics or math skills. Prepare some key questions such as, How do you use math to pay bills? do taxes? invest? budget? cook? sew? do woodworking? garden? etc. Using their math books as a resource, students might also prepare a list of key topics, for instance, rounding whole numbers and decimals, addition and subtraction of decimals, problem solving, reading graphs and charts, using geometric concepts, and so forth. They can ask their parents how they use these skills at home. After the interview, have the students prepare data summaries, graphs and charts, and figure averages. Ideas for data summaries are listed below. The summaries can be done in small groups or by the whole class.

Ideas for data summaries

1. What math skills are used most often at home? Have students count and tally the number of times each math skill was mentioned by their family members, and combine to find class totals. Make a bar graph to display the data for the 6 to 12 most frequently used skills.

2. Which family member uses math skills in the most ways at home? Have the class tally the number of ways math skills are used by their fathers, mothers, aunts, uncles, etc. They can then compute averages for each type of family member and make a table to display their findings.

3. Which types of home activities are most often mentioned as requiring math skills? Have the class decide on how they want to categorize home activities. Suggestions include:

Housework—cooking, yardwork, and repairs
Financial—paying bills, preparing taxes, and creating budgets
Shopping—for groceries, clothes, gifts, or household needs
Leisure activities—woodworking, sewing, gardening, and other hobbies

Then, have each student categorize and tally their family data. Combine the data for the entire class, and make a circle graph that shows the four major types of activities (or the number you decide on) and the percentage of times each was mentioned by family members. For example, your students may find a class total of 600 ways math is used at home. They might determine that 50% of these "ways" were in the financial area, 15% in housework, 30% in shopping, and 5% in leisure activities.

This activity can be expanded to survey the ways parents or other family members use math on their jobs.

Worksheet

Math in My House

Ways My Family Uses Math at Home	*Family Member*	*Math Skills Needed*

Activity

Class Allowance

Objective To determine how much the whole class spends in a year; to help students learn to make responsible consumer decisions

Grade Level Grades 6–9

Math Concepts/Skills Estimating, using statistics

Time Variable, depending on follow-up activities (You might want to make this a voluntary activity if some of your students do not have spending money.)

Materials Calculators and graph paper

Procedure [Many people don't realize how much money they spend over a period of time.] In this activity, individuals or small groups work out their spending habits for a year. Approximate weekly income and spending should be estimated for each student. If necessary, discuss different spending trends during the summer and holidays. Savings should be kept as a separate category. Use a calculator to total spending for the whole class and multiply by 52 to find yearly consumer power.

[Although many students do not receive lowances, most receive money to spend on themselves.] Have each student estimate personal spending for one week. Include milk and lunch money, allowance or earnings spent on school supplies, food, clothes, etc. Include only money that students actually spend themselves (not money spent "on" them). It will be necessary to discuss approximation and estimation skills. Your class will need to understand what "average spending per week" means, as well. You may want to have students keep a spending log for a week to verify their estimates.

Once everyone has computed their estimated average weekly spending, organize the results in a table, and have the class fill in their own personal record sheets. Have each student compute the class total for a week and multiply by 52 to find the yearly consumer power. Encourage the use of calculators for these computations.

This problem clearly demonstrates the usefulness of gathering statistics in order to investigate an everyday occurrence. Your class (and you) may be surprised at the amount of purchasing power in the twelve- through fourteen-year-old segment of our society. (TV advertisers would not be surprised, however.) The results of this problem can provide the basis for a most interesting values clarification activity to help students make responsible decisions in the marketplace.

Variation

After using the process described in the initial activity above, distribute catalogs containing popular items such as clothing or videos, and have students determine how their income can or cannot support their desires. Students can also plan for item purchases through savings.

Activity

TV Hours

Objective To determine the number of student TV-viewing hours in one year

Grade Level Grades 6–9

Math Concepts/Skills Using statistics, constructing bar graphs, calculating averages and percents

Time 30–40 minutes

Materials Graph paper, simple tally sheets, calculators

Procedure Families watch varying amounts of television. To complete this activity, you will want to try to select an "average week" of TV viewing. The validity of the results will depend on how "average" the week is. Each student should record the number of his or her TV viewing hours for one week. The TV hours for one week multiplied by 52 is an estimate of each student's annual TV-time commitment.

The table below is a sample record of one week's viewing.

	TV Hours	%
Monday	3	12%
Tuesday	2	8%
Wednesday	3	12%
Thursday	4	16%
Friday	2	8%
Saturday	6	24%
Sunday	5	20%
Total for week	25	100%
Total for year (x 52)	1,300	

This student watched about 1,300 hours of television in one year. If more or less television viewing took place during the week sampled than throughout the rest of the year, the total viewing hours would of course be inaccurate. However, for our purposes, the estimate is probably accurate enough. If more accurate results are desired, sample two or three randomly chosen weeks throughout the year and compute the total based on the average of these weekly figures. Some discussion of differing viewing habits during holidays and summer might be necessary. Students can then add all students' yearly TV hours and compute the average TV hours per student per week and per day. Also compute average percentage of TV viewing by day of the week—i.e., 10% on each weekday and 25% on weekend days.

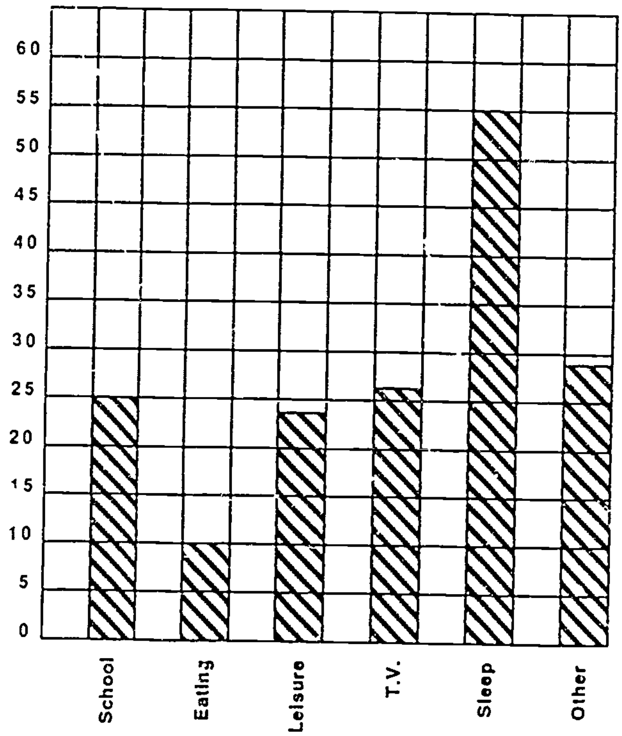
This activity was drawn from *Solving problems kids care about* by Randall Souviney.

Each student can also compute his or her percent of difference from the class average for a week or for each day. For example, if the class average were 20 hours per week, the student who averaged 25 hours would be 25% higher than the average.

Variation

1. It is also fun to compute the number of hours students are engaged in going to school, studying, eating, hobbies or leisure activities, and sleeping. The results can easily be graphed as shown below, offering a clear picture of life patterns. Each student can construct a personal bar graph, or an average class bar graph can be developed to show overall patterns. You may also want to have students construct pictographs and circle graphs of the same data; then, let them decide which graphs best convey the information.

What Is Your Life's Pattern?



The weekly graph above doesn't tell the whole story, however. Since school is generally in session for 36 weeks, and if we assume TV-viewing patterns are consistent throughout the year, this student attended school for only 900 hours and watched 1,300 hours of television ... an excellent topic for discussion.

2. Other topics of interest that can be effectively investigated using graphs include favorite foods, pets, TV programs, sport heros, number of brothers and sisters, and a birthday graph showing number of students with birthdays in each month.

Activity

Buying My School Clothes

Objective	To demonstrate to students how math skills are needed and used in making consumer decisions; to teach the value of money
Grade Level	Grades 6–9
Math Concepts/Skills	Estimating, calculating averages, using statistics
Time	15–30 minutes
Materials	Copies of adolescent clothing sections from current catalogs or store fliers, calculators
Procedure	Ask the class to decide (by vote) how much money would be needed to buy all a student's school clothes assuming all of his or her clothes had disappeared. Your students may originally come up with figures that are way out of line—either too little or too much. After preliminary tries, help them settle on a more realistic amount. Once the class has settled on a figure—i.e., \$100, \$500, \$1,000 or whatever—pass out copies of the catalogs or fliers, and let students select the school clothes they would buy for this "average student," keeping track of the amount per item and the cumulative total. Students can also figure average per item costs. If necessary, you may want to set some parameters for clothes selection; i.e., must have a coat, shoes, underwear, etc. Also, you may want to have students do this activity separately for a "female student" and a "male student." Do their clothes budgets differ?

Variations

1. Before students settle on a school clothes budget, let them look at the catalogs and estimate the necessary amount. In most cases, this should lead to more realistic outcomes than the first procedure.

2. Let students compare prices for comparable items from today's and very old catalogs. Your local library or historical society probably has copies of catalogs from the early 1900s. Many activities on differences, percentages, averages, and so on can stem from this exercise.

3. Besides estimating the amounts of money necessary to purchase school clothes, students can also use the catalogs to select Christmas presents within a budget or to furnish a room.

4. It would also be instructive to have students figure out how many hours they would need to work to purchase the clothes if they earned \$5 per hour.

Activity

Our House Beautiful

Objective
To help students understand the importance of math in skilled technical occupations

Grade Level
Grades 6–9

Math Concepts/Skills
Geometric concepts and spatial organization, calculating perimeters and areas, measurement

Time
At least two 45-minute periods

Materials
Drawing paper, rulers

Procedure
Invite a local builder or architect to display house plans and discuss the math used in their preparation. A female architect would be an excellent choice.

Invite the guest speaker to bring plans, elevations, photographs, and models of his/her work. Have the speaker describe how house size is calculated in total square feet and how drawings are prepared.

Subsequent to this visit, the class can design their own house. Ask students to prepare elevations. These drawings can be done at varying times, and the results displayed on the bulletin board. Have the class vote on their favorite house. Then, using the selected house, students can divide its space into various living areas: bedrooms, bathrooms, living room, dining room, kitchen, etc. Each space can be designed individually or in teams. The class again votes on the best effort and assimilates the design into the house.

Make sure that each student has input into the class house design. This activity should provide students with practice drawing to scale, measuring, calculating, and visualizing spatial relationships. At the end of the activity, help students relate the math skills they have practiced to the skills they would need to work in the building and construction industry.

Resources

Burns, M. 1975. *The I hate mathematics book.* Boston: Little, Brown.

For those students who "seemingly" hate mathematics, this book provides many relevant activities to boost confidence and aspirations. Positive attitudes toward mathematics develop as students experiment with and investigate the uses of mathematics in solving everyday problems. The activities are presented in a way that encourages students to have fun with mathematics.

DeRoche, E. F., and Bogenschild, E. G. 1977. *400 group games and activities for teaching math.* West Nyack, NY: Parker.

This book includes 400 classroom-tested math strategies and activities suitable for use in cooperative mathematics learning for elementary and junior high students. The activities are enjoyable and focus on the practical implications of learning math in a cooperative classroom atmosphere.

Fraser, S., ed. 1982. *SPACES: Solving problems of access to careers in engineering and science.* Berkeley: University of California, Lawrence Hall of Science.

A collection of thirty-two classroom activities designed to stimulate students' thinking about math-related careers, develop problem-solving skills, and promote positive attitudes toward math. Activities are designed for students in grades 4–10.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. The purpose of the program is ultimately to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes sections with activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction.

Massialas, B. 1983. *Fair play: Developing self-concept and decision-making skills in the middle school: Decisions about mathematics (Student guide* and *Implementation handbook).* Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

Decisions about mathematics includes many real-life activities to interest middle school students and to promote math-related careers. Activities are organized around the topics of "math and money," "collecting and analyzing data," and "your future."

Saunders, H. 1981. *When are we ever gonna have to use this?* Chart. Palo Alto, CA: Dale Seymour Publications.

If you want a quick answer for students' proverbial question "When are we ever gonna have to use this?", order this attractive wall poster. The chart gives students information on just which careers require knowledge of specific math concepts. The chart can also be useful for developing your own math-in-careers activities.

Saunders, H. 1980. "When are we ever gonna have to use this?" *Mathematics Teacher* 73, no. 1: 7–16.

This article describes the results of interviews with representatives from 100 different occupations. Various math topics are ranked by practical value and a number of recommendations for teaching junior and senior high math are provided. The article also includes eighteen interesting sample word problems, each related to a different occupation.

Souviney, R. J. 1981. *Solving problems kids care about.* Palo Alto, CA: Scott, Foresman.

Solving problems kids care about is divided into two parts. Section 1 includes notes and strategies for teaching mathematical problem solving. Section 2 contains thirty real-world problems that encourage divergent and logical thinking. Many of the problems have a range of acceptable solutions and multiple solution strategies, so students have the opportunity to be creative, independent thinkers. Activities are designed for elementary through junior high school students; teachers will enjoy them also.

Providing Information on Math-Related Careers

Awareness of math-related careers increases students' understanding of the usefulness of mathematics. Typically, teachers at all levels—elementary through college—spend little or no class time discussing the careers for which mathematics is important. Therefore, students frequently make uninformed career decisions. This is especially true for girls, who typically choose traditional careers very early in their lives, before they have received enough information about other possibilities. Girls also often exhibit uncertainty of goals and lack of career planning.

- Girls continuing the study of math were more attuned to career plans than those not electing to continue high school math studies. (Stallings 1985)
- Students are generally poorly informed about the actual uses of advanced mathematics, and their perceptions of the mathematical requirements of their career choices may be inaccurate. (Chipman and Wilson 1985)
- Much evidence indicates that teachers and parents reinforce boys for learning math and for planning math-related careers more than they reinforce girls for these activities. (Grayson and Martin 1988)
- Girls are or have been less well informed about the uses of mathematics than boys. (Chipman and Wilson 1985)
- There are large gender differences in students' reasons for working and their expectations for full-time careers. Boys typically expect to work full time, whereas many girls expect to have an interrupted or a part-time career (Fox et al. 1985). Boys see a career as a financial necessity or as a societal requirement; girls expect their future careers to provide challenge and personal fulfillment. (Franklin and Wong 1987)
- Even at the junior high level, girls' career preferences are related more to traditional sex role-related interests than to realistic assessment of their own mathematics achievement levels and abilities. (Jacobowitz 1983)

To help students understand why they need to learn math and how it can fit into their future career plans, we need to provide more information about math-related careers at the middle school or junior high school level. The suggestions on the following pages include some strategies and activities that you can use to help students begin thinking about math and careers.

Strategies

1. Invite guests, both male and female, who are enthusiastic about their work to speak to the class about how they use math in their jobs. Afterwards, tie the math topics they discussed to your current curriculum and to math courses your students can take in high school.

2. Have students conduct a survey of their parents' friends and neighbors, asking what they do for a living and how they use math in their occupations. Let them aggregate the data, figure averages, and so forth.

3. Have students generate a list of television personalities who use math on their shows.

4. Display posters on careers in math (see resource list at the end of this section), and take a few minutes at the beginning or end of the period to make the poster a game. Ask what a particular career is. Assign a student to research a career at the library and report back to the class. Have the students speculate about what a person in this career does and the math they needed in high school and college. Ask if any of your students are considering this occupation.

5. Math textbooks sometimes include supplementary material that describes careers that are linked to current course work in math. Take every opportunity to discuss these occupations, encourage students to work toward them, and (where possible) report incidences of women employed in these fields.

6. Use the career stories in the "Providing Positive Role Models for Girls" section of this guide, plus descriptions of careers found in some of the resource books listed. Discuss how people in these careers use math.

7. Although career information in counselors' offices varies by school, it is generally acknowledged that counselors, especially at the high school level, are well-supplied and well-versed in career-related information. Invite them to make presentations to your classes and to target girls for careers in science and math areas.

8. The "Job Sort" and "Odds on You" games found in *Use EQUALS to promote the participation of women in mathematics* by Kaseberg et al. and the "Math Used in Jobs" game found in *SPACES* by Fraser (see both in resource list) are excellent in helping students begin to think about occupations, careers, and the education they will need to enter these occupations and careers.

9. Some junior high schools have several "dress-up days" throughout the school year. Ask your students to dress like someone in an occupation that uses mathematics; then, have each student tell how they would use math in that job.

10. Hold one or a series of "Expanding Your Horizons" conferences. The book by Koltnow (see resource list) is a guide to planning and conducting these conferences, which help girls learn about math- and science-related careers.

11. A similar series of conferences in England is called "Be a Sumbody." At these workshops, girls receive information on careers and math; they also attend "girl-friendly" sessions on Logo, 3-D models, probability, measurement, calculators, games, and puzzles. These conferences are described in Burton's book (see resource list).

12. Most state employment security departments publish one or more free reports every year containing information on the numbers of jobs currently available in each occupational classification, number of people in each area, future projections of job supply and demand, and salary information. These publications make excellent resources for activities students can use to practice math skills and learn about careers.

13. Several brochures that detail the amounts of high school math needed for various occupations or for various college majors are listed as resources in this section. Most are free or very low cost. These are excellent handouts for students and parents to use in planning high school coursework. It is extremely important that junior high students begin thinking about these topics.

Activity

Who Uses Math?

Objective

To help students become aware of different occupations and how each uses mathematics

Grade Level

Grades 6–9

Math Concepts/Skills

Problem solving, calculating percentages

Time

20–30 minutes per period (can be used as a continuing activity)

Materials

Poster chart *When are we ever gonna have to use this?* or a copy of the article by Saunders (see resource list); career information books (see resource list and your school counselor), calculators (The poster is available from Dale Seymour Publications, P.O. Box 10888, Palo Alto, CA 94303 [order no. DS01344].)

Procedure

Select from the chart or the article ten to fifteen occupations that you think the students in your class are already familiar with, and put the name of each on the board. For each occupation, ask students how many think this is mostly a job for a man, mostly a job for a woman, or a job for any person. Clear up any misinformation about sex roles at this time.

Divide students into pairs or small groups, and assign one occupation to each group. Then, using information from the career books, help each group of students write a job description for each occupation, including what persons in that position typically do, the types of tools or equipment they use, where they work (in a lab, etc.), and the ways they use mathematics in their jobs. Students can use the chart by Saunders to get ideas on math use in various occupations. Have students share their reports with the whole class.

Depending on the math concepts you are currently studying, let students make up math problems about people performing their jobs. See the following example:

> The speed limit was 50 mph. The police officer stopped a car that was traveling 67 mph. How much over the speed limit, in percent, was the car going? If the fine is $25 for the first 10 miles over the limit and $12 for each mile over that, how much would the motorist be fined?

Let everyone work these problems.

When your students have learned about the first set of occupations, introduce additional sets of ten to fifteen new occupations. For each group, use the same process, helping students learn what the persons do, the tools or equipment they use, where they carry out their jobs, and the ways they use mathematics.

If students are unable to obtain enough information on particular occupations, have them conduct an interview by phone or in person with one or more persons in those career fields.

Variation

Another activity would be to make a list of the concepts you have covered in your math class, and have students list all the occupations that use these math operations or concepts.

Activity

Stimulating Interest in Math Careers Using Outside Sources

Objective

To help students become aware of the need for mathematics in the world beyond the formal setting of the classroom

Grade Level

Grades 6–9

Time

Variable

Procedure

Many school districts are featuring "Career Days" for high school students, and it is important that middle school and junior high students also attend. Find out about these activities, and make sure your classes are included as participants.

Variation

Arrange for field trips that allow students to observe how studying math will enable them to pursue interesting careers. Suggestions include universities or colleges, the telephone company, water treatment facilities, and other large technical/professional companies. Plan the field trip with the intent to stimulate further study of math.

Activity

Classify the Classifieds

Objective

To allow students to discover the relative number of males and females in some professions and learn about a variety of careers; to develop and practice skills in tallying, computing percents, researching information from original sources, and constructing charts and graphs

Grade Level

Grades 6–9

Math Concepts/Skills

Constructing bar graphs, using statistics, computing percents

Time

Two 30–40 minute periods

Materials

Copies of the yellow pages phone book from a large metropolitan area; copies of the "Tally Sheet," "Chart of Classified Occupations," and "Graph of Yellow Page Occupations" worksheets on the following pages; crayons or colored pens

Procedure

Obtain a copy of the Yellow Pages phone book for every two students. The books can be local or out-of-town and need not be current. Books are often available free from your local phone company, or students can bring borrowed books from home for one day. Give each pair of students a copy of the "Tally Sheet," use one copy of the "Chart of Classified Occupations" for the entire class, and give each student a copy of the "Graph of Yellow Page Occupations" worksheet. Tell students that they will use the Yellow Pages to look up several professions. By identifying first names as male or female, they can calculate approximately what percent are men and what percent are women in these professions

Some occupations that will probably be listed in your local telephone book include:

- Accountant
- Architect
- Attorney
- Dentist
- Engineer: civil, consulting, mechanical, structural, mining, electrical, and many other breakdowns
- Optometrist
- Physician: pediatrician, psychiatrist, general practice, surgeon, and many other breakdowns

Before distributing the phone books, help the class generate a list of occupations that are listed in the Yellow Pages. Write the list on the chalkboard and have a students check the list against the phone book. Look for categories that include individual names.

Ask students the following questions:

- Are there the same number of men and women in most occupations?
- Are secretaries and carpenters listed in the Yellow Pages?
- What do you find when you look up electrician?
- Does the list of gardeners include names of many individuals?

When the list is complete, assign each pair of students an occupation from the chalkboard. Write each pair's occupation on the classified chart. (You may want to reproduce this chart on the board, or use an overhead projector.)

- Which occupation do you think will have the most names?

Have the students estimate what percent of the people in each occupation are male and what percent are female. Let the pair that has the occupation make the estimate.

- Are there more men or women in this category?
- Have you ever seen a woman doing this job? a man?

Record the estimates on the chart. Enter the estimates for females in column 4 and the estimates for males in column 7.

- Do the male and female percentages for each occupation add up to 100%?

Distribute the phone books and tally sheets. Be sure estimates are made before phone books are passed out. Discuss tallying with students, if necessary.

- What does a tally show?
- Who really uses tallies?

Tally part of a list with the class to make sure the instructions are clear. Arrive at rules for including or excluding any given name. An overhead projection of a phone book page may be helpful.

- Is "Leslie" a man's name or a woman's name?
- Are "Marion" and "Marian" the same?
- What about an initial?

- Do we need to keep a record of names we don't use?
- Do we need a total count?

Have the students locate their occupation in the phone book. One student reads the first names from that section while the second student makes a count on the tally sheet.

When tallying is complete, ask students to compute percents on the tally sheet, following the instructions given.

After you and your students have entered information from the tally sheets onto the classified chart, review the results.

- Were estimates close to actual figures?

Make a graph of the occupations, showing male and female percents. There are many ways to present this information in graphic form. Depending on student experience, allow students to create their own graphs or have them complete the bar graph on the following pages.

After the graphs have been completed, discuss the meaning of the graph in relation to the statistics.

Variation

Instead of using the Yellow Pages for this activity, you may use directories from professional societies or state registries (for example, engineering directories). Also, city directories are a possibility, as well as university phone books (to see which subject areas contain the most male and female professors).

Worksheet

Tally Sheet

Date ______________________ Occupation ______________________

Student names ______________________ ______________________

Source of information ______________________

Tally of Female Names	*Tally of Male Names*

Summary

Enter on the "Chart of Classified Occupations"

Total number of tallies, male and female	______	Enter tally total in column 2
Number of names identified as female	______	Enter in column 3
Percent of names identified as female	______%	Enter in column 5
Number of names identified as male	______	Enter in column 6
Percent of names identified as male	______%	Enter in column 8

Worksheet

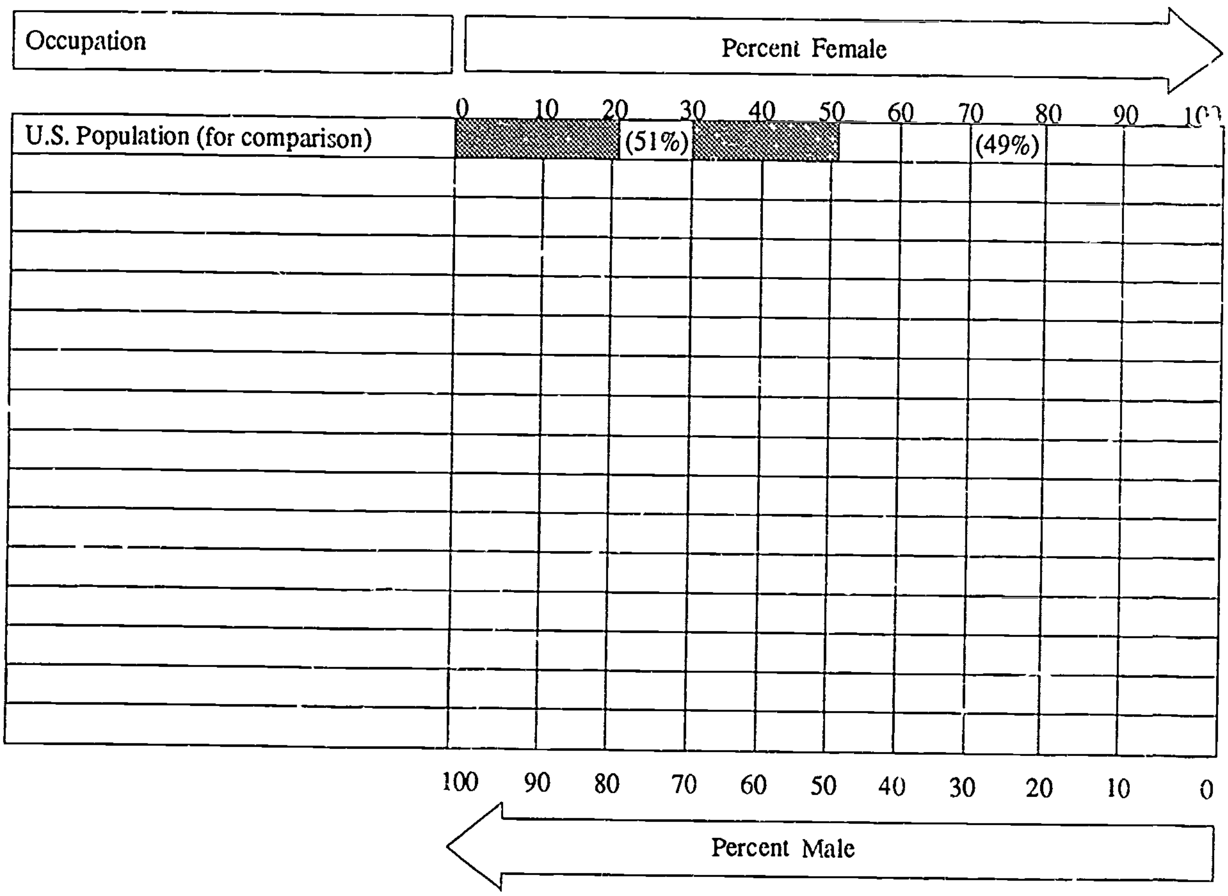
Chart of Classified Occupations

Location ______________________________

Occupation 1	Total Count 2	Female			Male		
		Tally Count 3	Est. % 4	Local % 5	Tally Count 6	Est. % 7	Local % 8

Worksheet

Graph of Yellow Page Occupations



Directions: Write the name of the occupation in the left column. Make a line on the bar space under the number that represents the percent of females (numbers at the top of the chart) in this occupation. Color the bar space from zero to that line with crayon, colored pen, or pencil. Color the rest of the bar space another color. The second color represents the percent of males in this occupation. (Read the percent from the bottom of the chart.)

Activity

Where Are the Jobs?

Objective To increase students' awareness of opportunities in various occupational fields

Grade Level Grades 7–9

Math Concepts/Skills Developing and using statistics, computing percents

Time One class period

Materials Two copies of Sunday's "help wanted" section of your local newspaper (or if your community is very small, use the ads from a nearby metropolitan area paper), "Where Are the Jobs" tally sheet (on following page), calculators

Procedure Divide the newspaper want ads into sections, and assign one to each pair of students in your class. (You will need two copies of the paper because of front-to-back printing.) Have students tally the number of ads for each job title. If more than one worker is requested in an ad, students should tally the number on their sheets. In the salaries column, students can jot down any information on salaries that is listed in the ad--e.g., $10/hour or $2,100/month.

After the tallies are finished, have students complete, on the chalkboard, a master list of occupations and the number of persons needed for each. Are each of the occupations different, or do some job titles mean the same thing? Using the master list, students can calculate the percentage of all jobs advertised in the newspaper for each occupation.

Also, if salary information is available, have students find the average *annual* salary for each occupation. Is there a relationship between salaries and the amounts of math people need for jobs? between salaries and education?

Variations

1. Expand the tally sheet to include columns for education, training, experience, and any specific skills or qualifications mentioned in the ad—i.e., must type 60 w.p.m. or must have a valid driver's license.

2. Use this activity as a comparative study. Obtain ads from newspapers in other cities. Students can compare numbers and percentages of employees needed in each occupation and also compare salary information.

3. Another very interesting comparison can be carried out using ads from different time periods. If possible, obtain newspapers that are several years old. (You may find old newspapers on microfilm at the local library.) A comparison of the want ads can show how occupations, salaries, and titles have changed. Students can also compare and discuss the types of jobs listed in the ads for men and women. This would be a good activity to conduct jointly with a U.S. history teacher.

Worksheet

Where Are the Jobs?

Job Title	*Number of Persons Needed*	*Salaries*

Activity

Jobs of the Future

Objective

To expose students to statistical projections; to allow them to learn about job demand while practicing math skills

Grade Level

Grades 6–9

Math Concepts/Skills

Whole numbers, calculating percentages, constructing line graphs, using statistics, estimating

Time

One class period

Materials

"Employment in Selected Occupations: Actual 1984 and Projected 1995" worksheet (on page 115), graph paper, calculators

Procedure

The "Employment in Selected Occupations" worksheet includes 55 occupations selected from a table on U.S. employment in over 300 occupations that have 25,000 or more workers.

Copy the worksheet for each individual or pair of students in your class. Explain what "employment projections" are and how one arrives at those estimates. Labor economists develop employment projections by a complex series of operations. These include determining the rates at which employment in a particular area has been declining or increasing over the past several years, estimating allowances for social changes and expectations (e.g., as women join the labor force, the number of daycare workers needed will increase by 5% each year), and then applying these rates and estimates to current employment figures. For example, if the number of librarians has been increasing by 1% per year for the last 10 years and we don't have any reasons to assume that the rate will change, we would forecast or project a 1% increase in librarians per year in the future. Have students read the material in the worksheet and answer the following questions:

a. What do these numbers represent? How do you read them? (The "in thousands" means they will have to add 3 zeros to all numbers, so 4,500 in the table would actually represent 4,500,000.) Ask students to read aloud various numbers to make sure they understand this concept.

b. Which of these occupations employs the most people?

c. Which of these occupations employs the least?

d. Which do you think will be the fastest growing, according to the projections for 1995?

e. Which occupations will be growing the least?

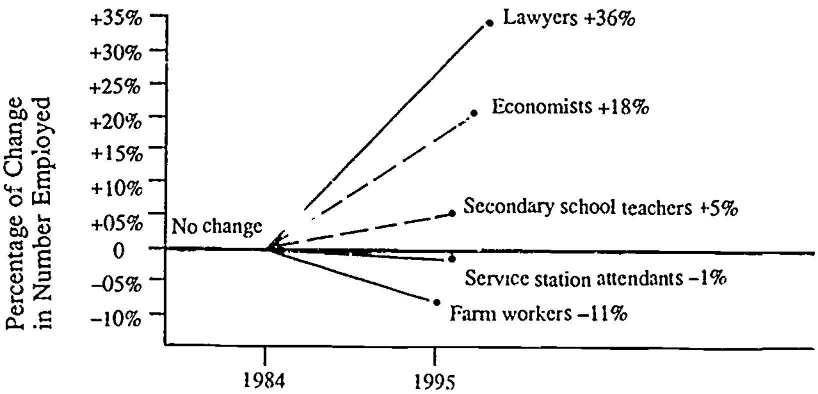
f. Will any occupations employ fewer people in 1995 than in 1984? How can you explain these projected differences?

h·· e students compute the percentage of increase or decrease between 1984 statistics and 1995 projections for each occupation. To save time, assign two occupations to each student. Let students fill in the percentage of change for each occupation, and then ask questions d and e again. *Note:* Instructions for calculating these percentages are given at the end of the worksheet. If you prefer to use different written instructions, just substitute them in duplicating.

Assign or let each student select four or five occupations to graph. Put an example on the board with percentage of change on the *y* axis and two years—1984 and 1995—on the *x* axis. Have students construct and label line graphs showing change in employment for their selected occupations, as in the example sketched below. Put these graphs up on the wall, and let students study them. Discussion questions could include:

a. Are the fastest growing occupations always the ones with the most people employed?

b. Which occupations will have the most job openings in 1995, according to our table? Which occupations will employ the fewest people?



Variation

Order the employment projections report cited in the worksheet. (It can be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.) The entire table (pp. 44–49 of the report) contains approximately 300 occupations. Many of these will be unfamiliar to your students, and the material can serve as a good resource for learning about various careers that are not commonly known.

Worksheet

Employment in Selected Occupations: Actual 1984 and Projected 1995

Total Employment (in thousands)

Occupation	*1984*	*1995*	*Percent of Increase or Decrease*
Accountants and auditors	882	1,189	________
Aircraft pilots	79	97	________
Architects	93	118	________
Artists	204	264	________
Carpenters	944	1,046	________
Chemical engineers	56	69	________
Chemists	85	94	________
Civil engineers	175	222	________
College teachers	731	654	________
Computer operators	241	353	________
Computer programmers	341	586	________
Computer systems analysts	308	520	________
Cooks	884	1,095	________
Dental hygienists	76	98	________
Dentists	156	195	________
Drafters	345	384	________
Economists	38	45	________
Electrical and electronics engineers	390	597	________
Electricians	545	633	________
Engineers	1,331	1,811	________
Farm workers	1,079	958	________
Firefighters	243	280	________
Flight attendants	64	77	________
Foresters and conservation scientists	25	27	________
Geologists and geophysicists	46	53	________
Lawyers	490	665	________
Licensed practical nurses	602	708	________
Mathematical scientists	51	63	________
Mechanical engineers	237	317	________
Mechanics, installers, repairers	4,391	5,038	________
Musicians	192	217	________
Paralegal personnel	53	104	________
Pharmacists	151	166	________
Physical therapists	58	83	________
Physicians and surgeons	476	585	________
Plumbers	395	455	________
Police and detectives	520	586	________
Postal mail carriers	281	389	________
Preschool and elementary teachers	1,381	1,662	________
Printing press operators	222	248	________

Occupation	*1984*	*1995*	*Increase or Decrease*
Producers, actors, directors	50	61	______
Psychologists	97	118	______
Real estate agents and brokers	363	415	______
Receptionists and information clerks	458	542	______
Registered nurses	1,377	1,829	______
Reporters and correspondents	69	82	______
Salespersons (retail)	2,732	3,075	______
School principals	125	137	______
Secondary school teachers	1,045	1,093	______
Secretaries, stenographers, and typists	4,027	4,209	______
Service station attendants	303	297	______
Social workers	335	410	______
Travel agents	72	103	______
Truck drivers	2,484	2,911	______
Veterinarians	40	48	______
Waiters and waitresses	1,625	2,049	______
Writers and editors	191	245	______

To find the percent of increase or decrease:

1. Find the difference *(d)* between 1995 projected employment *(b)* and 1984 employment *(a)*: $d = b - a$. (If there was an increase, d will be positive; if there was a decrease, d will be negative.)

2. To find the percentage of increase or decrease *(p)*, $p = d/a$

3. Solve the equation for each occupation; round each percentage to the nearest whole percent. If there was a decrease, put a minus sign before the percentage.

Employment information from Bureau of Labor Statistics. 1986. *Employment projections for 1995. Data and methods.* (Bulletin 2235). Washington, D.C.: U.S. Department of Labor.

Activity

Math Needed for College

Objective

To make students aware of the limited career options they will have without three or four years of high school math

Grade Level

Grades 7–9

Math Concepts/Skills

Using statistics, constructing circle and bar graphs, calculating percentages

Time

30–40 minutes

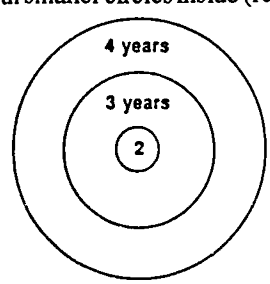
Materials

"Math in High School You'll Need for College" table on following page, several large pieces of butcher paper, calculators

Procedure

Make a copy of the table for each student. Tell students to develop a simple tally sheet, and count and determine what percentage of programs in each major field requires four, three, and two years of math. What are the overall percentages of programs requiring four, three, and two years of math?

Divide students into small groups, and give each group a large piece of butcher paper on which they can construct a graphic representation of these data. The graph should include the names of all of the program fields. Students could draw a large circle graph showing percentages of fields requiring four, three, and two years of math and listing the names of the programs within each area. Or, they could draw a large bar graph, again listing the fields within each bar. There are other ways that the students can demonstrate that four years of math cover all the options while two years cover only a narrow range. They could draw a large circle (representing four years of math) with smaller circles inside (representing two or three years of math).



Discussion questions:

1. What does this data tell us about the importance of math?

2. How many of these fields could you major in if you had had four years of math? How many of these fields could you major in with three years of math? two years? Conclusion: Four years of math in high school keeps your options open.

Handout

Math in High School You'll Need for College

Major in College	*Years of High School Math Needed*
Agriculture:	
Agricultural economics	3
Entomology	3
Environmental sciences	4
Food sciences	3
Forestry	3
Genetics	3
Landscape architecture	3
Plant pathology	3
Rural sociology	3
Wildlife ecology	3
Other areas of agriculture	2
Architecture	3
Art	2
Business:	
Accounting	3
Economics	4
Management	4
Communications	2
Education:	
Child development and preschool	3
Elementary	3
Engineering	4
History	2
Language and literature	2
Law	3
Life sciences:	
Bacteriology	4
Biochemistry	4
Biology	4
Linguistics	3

Major in College	*Years of High School Math Needed*
Mathematical sciences:	
Mathematics	4
Statistics	4
Actuarial science	4
Computer science	4
Medicine:	
Allied medicine	3
Dental hygiene	3
Dentistry	4
Medical technology	4
Nursing	3
Optometry	4
Physical therapy	3
Pre-medicine	4
Public health	3
Music	2
Pharmacy	4
Philosophy	2
Physical science:	
Astronomy	4
Chemistry	4
Geology	4
Physics	4
Social sciences:	
Anthropology	2
Asian studies	2
Black studies	3
Geography	3
Political science	3
Psychology	4
Social welfare	2
Sociology	3
Theater	2

Activity

Facts in Graphs

Objective

To provide information to students on relative salaries for different college majors

Grade Level

Grades 6–9

Math Concepts/Skills

Using statistics, computing percentages and projections, constructing bar and circle graphs

Time

30–40 minutes

Materials

"Numbers of Men and Women in Each Degree Field and Average Salaries" worksheet on page 121, graph paper, protractors, resource materials on math-related careers, calculators

Procedure

Copy the worksheet for each student. Explain that the table on the worksheet shows the number of people with degrees and the average monthly salary for people from a university, community college, or postsecondary vocational school in each of the fields listed. The degree could be a bachelor's; an advanced degree, as in medicine; or a one- or two-year degree from a vocational school. Allow students to study the information and answer the following questions:

1. In which degree fields do people earn the highest salaries?
2. In which degree fields do people earn the lowest salaries?
3. Which fields do most male college graduates enter?
4. Which fields do most female college graduates enter?
5. Which field is currently the most popular for all students?
6. Which field is currently the most popular for female students?
7. Which field is currently the most popular for male students?

Ask students to (1) construct a bar graph showing the *annual* salaries for each degree field in order of highest to lowest and (2) construct a circle graph for each degree field, showing the percentage of men and women in each. (To do this, students have to add the number of men and women in each field and then compute the percentages.) Put the circle graphs on the board in three groups—those with approximately equal numbers of men and women, those with a majority of men, and those with a majority of women.

Discussion questions

1. Is there a relationship between the salaries paid in a field and the percentages of men and women in the field? Do more men go into the highest-paying fields? Do more women go into the lowest-paying fields?

2. Which of these fields require the most math? (Students can refer to the poster by Saunders and resource material to help answer these questions.) Which of these fields require the least math? Is there a relationship between the salaries and the amount of math required? If the inflation rate is 3% per year, how much will these fields pay when you are graduating from college?

3. A recent newspaper article reported that women college graduates who worked full time in 1986 earned 70% of what men earned. Can you think of one reason for this?

4. It was reported in recent a newspaper article that mathematicians are becoming an endangered species—only 362 U.S. citizens obtained doctorate degrees in math during the 1986–87 school year. At that rate there will be a severe shortage of mathematicians after the year 2000. What do you think will happen to salaries for people with math majors?

5. Sometimes statistics can be deceiving; for example, in 1972 only 10% of doctorates in math were awarded to women; in 1987, 20% of doctorates in math were awarded to women. Do you think the number of women in math increased? Actually, there were 78 women Ph.D.'s in 1972 and only 73 in 1987. How could the number of women with doctorates in math decrease while the percentage increased?

Variation

Students can write a paragraph on their lifestyles at ages 32–35. From this, help them figure out how much some aspects of their lifestyles—houses, cars, families, etc.—will cost 20 years in the future. Help them estimate the incomes they will need to support this lifestyle.

Numbers of Men and Women in Each Degree Field and Average Salaries

Degree Field	*Number of Men* (numbers in thousands)	*Number of Women*	*Total*	*% Men*	*% Women*	*Average Monthly Income in Dollars*	*Average Annual Income in Dollars*
Agriculture	513	48				2,110	
Biology	353	312				1,718	
Business/management	4,232	2,456				2,215	
Economics	415	78				2,824	
Education	1,584	4,151				1,526	
Engineering	2,533	245				2,707	
English/journalism	419	662				1,544	
Home economics	30	397				1,063	
Law	789	157				3,726	
Liberal arts/humanities	1,331	1,824				1,383	
Mathematics/statistics	386	198				2,111	
Medicine/dentistry	735	242				3,440	
Nursing, pharmacy, technical health	267	2,431				1,299	
Physical earth sciences	586	224				2,554	
Police science/law enforcement	268	56				1,809	
Psychology	318	490				1,543	
Religion/theology	434	100				1,530	
Social sciences	896	1,012				1,666	
Vo-tech studies	1,026	563				1,456	
Other	1,419	1,069				1,692	

From Kominski, R. 1987. *What's it worth? Educational background and economic status. Spring 1984.* Washington, D.C.. U.S. Bureau of the Census...

Resources

American Institutes for Research. 1980. *Programs to combat stereotyping in career choice.* Palo Alto, CA: American Institutes for Research.

In this book, sex stereotyping in career choice is discussed, and nine programs designed to expand students' career awareness and break stereotypical patterns are described. Many of the programs are suitable for junior high students.

American Statistical Association. n.d. *Careers in statistics* and *Statistics as a career: Women at work.* Pamphlets. Washington, DC: American Statistical Association.

In these pamphlets, career opportunities in statistics are described, and statistics careers for women are highlighted.

Askew, J. 1982. *The sky's the limit in math-related careers.* Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

This interesting book describes contemporary women in highly math-related occupations. Each of the chapters—on computers, engineering, finance, math education, research mathematics, and statistics—includes several pictures and quotes from women about their jobs and the satisfaction they receive from them. Content is suitable for upper elementary, junior high, and high school students.

Burton, L., ed. 1986. *Girls into maths can go.* London: Holt, Rinehart and Winston.

This book brings together literature on gender differences in math performance and attitudes, analyzes the problem, and offers several strategies as solutions. The aim of the book, which serves as the text for an in-service course in England, is to heighten educators' awareness of math equity issues and strategies that can be used at all levels of education.

Campbell, P. B., and Katrin, S. E. 1978. *Sex stereotyping in math doesn't add up.* Groton Ridge Heights, Groton, MA.

This unit on sex stereotyping and its effect on math education includes instructions, a 25-minute audiotape, four transparency masters, two handouts, and a bibliography. Topics covered include stereotyping, math word problems, sex differences in math skills, and math courses and job choices. The materials are suitable for junior high students, and the unit, with activities, takes between one and two hours to complete.

Casualty Actuarial Society. n.d. *The actuarial profession.* Pamphlet. New York: Casualty Actuarial Society.

A pamphlet describing career opportunities for actuaries.

Downie, D.; Slesnick, T.; and Stenmark, J. K. 1981. *Math for girls and other problem solvers.* Berkeley: University of California, Math/Science Network.

The activities in this book encourage independent thinking and creativity in mathematics. Students and teachers are encouraged to think about problem solving in versatile ways and forms. Although this book was originally designed for females, the activities are appropriate and interesting for both boys and girls ages 7–14. The book would also be an excellent resource for math clubs.

Equal Employment and Affirmative Action Office. 1987. *Why take more math?* Brochure. Seattle: University of Washington.

This interesting brochure includes reasons for selecting math courses in high school and math requirements for various college majors. Although specifically written for the University of Washington, the information applies to most colleges.

Erickson, T. 1986. *Off and running: The computer off-line activities book.* Berkeley: University of California, Lawrence Hall of Science.

Off and running was developed to encourage minority and female interest in computers, math-based fields of study, and math-related careers. The content of the book includes on-line and off-line activities that teach computer concepts and skills. Activity themes focus on learning programming skills, cooperative learning, and equity in computer usage. This book has coupled excellent educational materials with strategies to promote equity. Content is suitable for grades 5–12.

Fraser, S., ed. 1982. *SPACES: Solving problems of access to careers in engineering and science.* Berkeley: University of California, Lawrence Hall of Science.

A collection of thirty-two classroom activities designed to stimulate students' thinking about math-related careers, develop problem-solving skills, and promote positive attitudes toward math. Activities are designed for students in grades 4–10.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. The purpose of the program is ultimately to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes sections with activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction.

Kenschaft, P. 1986. *Careers for women in mathematics.* Brochure. Wellesley, MA: Association for Women in Mathematics.

This brochure describes the types of careers available in mathematics and the amounts of high school and college math required for them. It also discusses discrimination against women in mathematics-related careers, suggests strategies for dealing with such discrimination, and presents statistics on women in mathematics. Several other pamphlets and brochures on mathematical careers are referenced in this brochure.

Koltnow, J. 1980. *Expanding your horizons in science and mathematics.* Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

This booklet is a guide to planning and conducting conferences for seventh through twelfth grade girls on math/science careers. The conference format includes talks by role models and hands-on math and science activities for the girls attending.

Kreinberg, N., ed. 1977. *I'm madly in love with electricity and other comments about their work by women in science and engineering.* Berkeley: University of California, Lawrence Hall of Science.

This interesting and inspiring book includes selected comments about their work from women scientists, engineers, and mathematicians.

Comments are organized into sections about careers in math, engineering, physics, astronomy, chemistry, and life sciences.

Massialas, B. 1983. *Fairplay: Developing self-concept and decision-making skills in the middle school: Decisions about mathematics (Student guide* and *Implementation handbook).* Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

Decisions about mathematics includes many real-life activities to interest middle school students and to promote math-related careers. Activities are organized around the topics of "math and money," "collecting and analyzing data," and "your future."

Mathematical Association of America. n.d. *Careers in mathematics.* Pamphlet. Washington, DC: Mathematical Association of America.

This pamphlet contains an extensive list of references pertaining to mathematics and mathematics-related employment. Although the pamphlet is slanted toward high school students, it presents information that should be made available to all junior high students.

Mathematical Association of America. n.d. *The math in high school you'll need for college.* Pamphlet. Washington, DC: Mathematical Association of America.

This interesting pamphlet includes information on the content of high school math courses and a list of college majors with the number of years of high school math needed for each. Although the pamphlet is slanted toward high school students, it presents information that should be made available to all junior high students.

Mathematical Association of America. n.d. *Professional opportunities in mathematics.* Pamphlet. Washington, DC: Mathematical Association of America.

Career opportunities in mathematics-related fields are described in this pamphlet, which includes information suitable for junior high students.

Mathematical Association of America. n.d. *You will need math.* Pamphlet. Washington, DC: Mathematical Association of America.

This pamphlet discusses the reasons that students will need math and lists the amount of high school and college math required for jobs in many different fields. Although the pamphlet is slanted toward high school students, it presents information that should be made available to all junior high students.

Mitchell, J. S. 1982. *I can be anything: A career book for women.* New York: College Entrance Examination Board.

This book provides specific information on a number of math, science, technical, and nontraditional blue collar jobs. Each entry includes a description of the work, educational requirements, information about women in the field, economic outlook, and sources of additional information.

National Council of Teachers of Mathematics. n.d. *Mathematics teaching as a career.* Pamphlet. Reston, VA: National Council of Teachers of Mathematics.

This pamphlet describes career opportunities in mathematics education.

Saunders, H. 1981. *When are we ever gonna have to use this?* Chart. Palo Alto, CA: Dale Seymour Publications.

If you want a quick answer for students' proverbial question "When are we ever gonna have to use this?", order this attractive wall poster. The chart gives students information on just which careers require knowledge of specific math concepts. The chart can also be useful for developing your own math-in-careers activities.

Saunders, H. 1980. "When are we ever gonna have to use this?" *Mathematics Teacher* 73, no. 1: 7-16.

This article describes the results of interviews with representatives from 100 different occupations. Various math topics are ranked by practical value and a number of recommendations for teaching junior and senior high math are provided. The article also includes eighteen interesting sample word problems, each related to a different occupation..

Society for Industrial and Applied Mathematics. n.d. *Careers in applied mathematics* and *Profiles in applied mathematics*. Pamphlets. Philadelphia, PA: Society for Industrial and Applied Mathematics.

In these pamphlets, career opportunities in applied mathematics are described, and selected employers in the field are profiled.

Wiggan, L., ed. n.d. *Dropping math? Say goodbye to 82 jobs*. Chart. Canada: Toronto Board of Education, Mathematics Department.

A brightly colored 18" x 24" poster that displays, in graphic form, each level (in the Canadian school system) of mathematics required for 82 jobs. You can easily relate the Canadian levels to those in the United States. The poster is suitable for students in grades 5–12.

Providing Positive Role Models for Girls

In addition to "book learning," one of the significant ways we learn is by watching and emulating the behavior of role models. Boys and girls see their parents, teachers, and other adults as role models of appropriate adult behavior. If girls are exposed only to women in traditionally feminine careers roles, they will "learn" that nontraditional careers are not appropriate for them. Many girls rarely see women functioning in technical and highly math-related careers. To increase girls' awareness of all their options, we need to make a special attempt to provide female role models who enjoy and are using mathematics in their everyday lives and careers.

- Exposure to salient role models is extremely important in determining girls' career choices. Female enrollment in undergraduate majors paralleled the proportions of female teachers within a discipline. (Fox 1981)

- In school, students see male teachers as role models in mathematics; in 1983, 83 percent of high school math and science teachers were male (Jones and Montenegro 1982). The more advanced a math course is, the more likely it is to be taught by a male teacher. (Fox 1981)

- Female elementary preservice teachers have lower estimates of their math ability and feel less comfortable teaching math than their male peers. (Aiken, cited in Stage et al. 1985)

- Among girls who had taken four years of high school mathematics, girls with 50 percent or more female high school math teachers chose careers that were significantly higher in math-relatedness than did girls who had experienced fewer female math teachers. (Franklin, Small, and Loesch-Griffin 1988)

- Both mothers and fathers of high math-achieving high school girls held jobs that were more highly math related than parents of high verbal/low math-achieving girls. (Franklin and Wong 1987)

- Adult females are less likely than males to engage in math activities and more likely to express doubts about their math abilities. Fathers are more likely to help their children with math homework than are mothers; mothers generally hold more negative views of their mathematics abilities and interests than do fathers. (Franklin and Wong 1987)

- Television programs (and movies) typically present females in traditional sex roles. We rarely see an attractive woman in a highly scientific or math-related career. (Fox 1981)

- Reading about successful women causes girls to have higher expectations of success and to spend more time on school tasks. (Campbell 1984)

These findings indicate that appropriate role models for girls are definitely underrepresented in society today, and this lack of role models could discourage some girls from engaging in mathematics-related activities and choosing math-related careers. To counter stereotypical views held by males, it is very important that boys also be exposed to females in math-related roles. Parental attitudes are also a very important factor in this area. Some ideas for working with parents can be found in the "Mathematics Promotion" section of this guide. The suggestions on the following pages will help you devise ways of providing role models appropriate for junior high level girls and boys.

Strategies

1. Prepare a bulletin board (or have students do it) of women who are mathematicians or scientists and successful in their professions. Be sure to discuss the board, and place it on a prominent wall. To reinforce their attention to the board, let students know that you may add a question or two about the subject matter to an upcoming test.

2. An excellent strategy is to invite female guest speakers to visit class and talk about how they use math in their careers. If you don't know where to find such women, use professional directories (i.e., directories of engineers or accountants) or contact your local university or the sex equity director at your state department of education. Some studies have found that male speakers who specifically and actively encourage young women to seek math- and science-related careers can also be extremely effective in promoting these careers. Student contact with role models involved in math and science careers (especially female role models) is very important, but preinterview guest speakers to ensure that they will communicate enthusiastically, positively, and effectively to adolescents. Help your guests use a vocabulary and definitions that your students will understand.

3. Mentors for individual seventh through ninth grade students (especially girls) can be used to encourage more technical career choices. Contact women in the workplace through service clubs such as Soroptimist, Toastmasters, business and professional women's organizations, and university speakers bureaus. Invite students of both sexes to after-school visits at the mentors' workplaces.

4. If you employ strategy 3 above, you may also be interested in getting together with other math teachers and organizing a community math support group that would include potential role models, people who would give tours, those who would sponsor internships or serve as mentors, and those who would help with math contests. This could become your school's Math Booster Club.

5. Use the stories on the following pages about real-life women working in math-related careers to interest your students in math and to provide role models. Encourage students to read and write stories about such women. The resource list following this section also contains publications that include stories about famous women mathematicians and scientists. Although these stories are useful in breaking down stereotypes (i.e., students learn that a woman really can be the first person to create a new branch of mathematics or devise a unique approach to specific problems), the women in these stories are often pictured as rather solitary persons who overcame great difficulties in order to "make it" in the male-dominated world of mathematics. If you use these stories, it is important that you counterbalance them with readings about women who hold challenging high-level math- or science-related careers and still maintain friends, family, and a wide range of outside interests. It is very important that girls learn they don't have to be "outstanding math stars" or give up families and other activities in order to be scientists or mathematicians.

6. Discuss role models for girls, as presented in the popular media. Point out how these portrayals may be biased, and help girls find other models that present a more balanced picture of women's roles.

7. Have students interview their parents and write brief papers about how the parents use math in their occupations. Select some papers to share with the class.

8. Junior high students also look to high school students as role models. Ask high school math teachers to select some good, confident male and female math students to make brief presentations to your class about the math they are studying and how they plan to use it in the future. Female college students can also be used to model math-related careers by presenting brief discussions about their studies and future careers.

9. Female teachers can serve as powerful role models for girls. If most of the math teachers in your junior high are male, try to devise some ways of exposing all students to female math teachers for at least part of their studies. You might consider team teaching; combining male and female teachers; or ensuring that as students progress through your school, they each have female math teachers for one or more courses.

10. Encourage a "math is fun and useful for everyone" attitude. Try to project a feeling of confidence, interest, and enthusiasm about math to your students. If you feel uncomfortable, or think your math skills are inadequate, take some courses and/or work with other teachers until you feel confident about your skills.

Activity

Stories about Real Women

Objective

To relate information about actual women involved in nontraditional highly math- and science-related careers who can serve as role models for girls

Grade Level

Grades 6–9

Time

5 minutes per story, plus discussion time

Materials

Stories on the following pages ("Geri—Nuclear Physicist," "Patti—Atmospheric Scientist," "Terry—Biochemist," "Carol—Computer Scientist," "Diana—Soil Scientist," and "Jenny—High School Math Teacher")

Procedure

Make copies of the stories on the following pages, and let students read them. Conduct a brief discussion. Ask students why they would or would not like to have a career similar to the one described in the story. These stories may also be used in conjunction with science activities.

Variation

Invite a woman involved in a similar career to speak to the class after piquing their interest with the story. Let students write their own stories about this person. Another variation would be to have students make up word problems and/or algebra problems using each of the women described in the stories as the central problem-solving character.

Handout

Geri—Nuclear Physicist

Geri is a nuclear physicist employed by a large government contractor. Her employer designs and manufactures rockets. Geri deals primarily with the design phase of the work. One of her duties is to ensure that the rocket motors she designs are powerful enough to launch a particular rocket. One of the most exciting moments of Geri's work occurs when rocket motors are test fired. While Geri and the other physicists she works with watch from a specially-built protective building, the rocket motor is started. During this testing phase, the motor is fastened to the ground and wired so that the designers can measure its propulsion capabilities by determining the amount of heat it generates. Unless the rocket motor has enough propulsion, or power, it won't be able to lift the rocket. During test firing, Geri and the other physicists also check the rocket's fuel lines to make sure they are clear enough for the propellant, the rocket's special fuel, to pass through. This part of her work is extremely dangerous.

Another part of Geri's job requires her to use a computer to analyze the ways that the motors she designs will fit all of the other portions of rockets. Through computer simulation, she can sometimes develop new stream-lined shapes for rocket components that increase the rockets' potential speeds. Geri also uses computer simulation to determine the distance a newly-designed rocket will fly or to predict where it will land. Like many other physicists, Geri is working on projects for the U.S. government. The design team she works with includes other physicists and engineers.

Geri enjoys her work very much because she is working as part of a team and she spends her time solving challenging problems and creating new designs. Much advanced math is needed for Geri's job. Geri was a good math student, and she enjoyed all of the math and science courses she took in high school and college. These included advanced algebra, geometry, trigonometry, calculus, chemistry, physics, and thermodynamics. She received a master's degree in nuclear physics from the University of Michigan.

Geri's life also includes time with her family and friends. When she's not working, she likes to go dancing with her husband and on fishing trips with her family.

Handout

Patti—Atmospheric Scientist

Patti's career is very challenging. She is an atmospheric scientist who works for a large center conducting environmental research. The gases that surround a planet are called its atmosphere; on earth, the atmosphere is our air. The study of weather is one part of atmospheric science. Some atmospheric scientists study the gases around distant planets. Patti studies the earth's atmosphere, and she is especially interested in studying the clouds that produce snow. She analyzes the clouds that form over mountains in the winter to learn all she can about their snow content. Since snow is an extremely important water source in the western part of the United States, atmospheric scientists like Patti need to understand why it snows, where it will snow, how much it will snow, and how to alter snowfall patterns.

One exciting way Patti studies clouds is to fly a specially-equipped plane through them. Her plane sends out a laser probe, a beam of light that can picture and record the amounts of ice crystals in the cloud and help her determine how much snow the cloud contains and how "wet" or "dry' the snow will be. Another method Patti uses in studying clouds is radar. She places a radar machine on the ground at the top of a mountain; the radar produces a picture of the clouds above it. From studying this picture, Patti can tell how high the clouds are and the characteristics of the snow they will produce. Patti uses computers to help her analyze the data and understand the information from the laser probe and radar.

To learn her job, Patti needed to know a great deal of math. She attended college and earned a bachelor's degree in mathematics and a master's degree in atmospheric science.

Besides studying snow clouds, Patti likes sports. On weekends she loves to go wind surfing with her friends in the summer and skiing in the winter. She also enjoys playing with her dog, Dalby.

Handout

Terry—Biochemist

Terry's career is fun, interesting, and extremely valuable. She is a biochemist who conducts basic research at a university. To understand Terry's job, you need to learn something about her field. Chemistry is the study of the composition of substances and changes in the composition of substances. Biochemists study plants and animals and their life processes. In carrying out basic research, scientists study an object or a process to understand how it works, then other scientists apply these basic principles to many other important areas. In fact, many advances in medicine, consumer products, and so forth, come from basic research that seems totally unrelated to these areas.

All living cells are surrounded by membranes, which are the materials that hold the cell together, yet allow substances in solutions to enter and leave the cell. Terry and several other researchers study the membranes of the cells found on certain kinds of molds, such as the mold that grows on oranges when they're left in the refrigerator and the fungus that grows in "humus" or decayed plant and animal material. Both of these molds are related to the antibiotic, penicillin. Some of the molds that Terry studies prefer to grow at very high temperatures—even up to 150 degrees. Others, like the mold on oranges, only grow at very cold temperatures. Terry grows these cells at different temperatures, looking at optimum and less than optimum conditions for growth. Then she separates the cells, using chemicals, and measures their membranes to see what happened to them under the experimental growing conditions. The cells are so tiny they can only be seen with a powerful microscope. Terry's work is useful because by studying cell membranes in molds and how they react to different temperatures, scientists can learn many things about the cells in our own bodies and about how medicine and other treatments can affect diseases.

Terry and her colleagues need a great deal of mathematics in their research. Terry uses math to calculate the size of changes she finds in cell membranes. Terry took all the math she could get in high school. Calculus is a special branch of math that deals with rates of change, and Terry uses it to understand her results. She also uses computers to make graphs of her findings and to help analyze her data. Terry has three college degrees: a bachelor's, a master's in chemistry, and a doctorate in biochemistry. She also took many classes in mathematics and physics to prepare for her career.

In addition to conducting research, Terry also enjoys teaching college biochemistry courses. Last summer several high school students worked with her in her laboratory, learning how to conduct basic research in biochemistry. At the end of summer, one of these girls said, "I never worked so hard or had so much fun." Another girl said, "I didn't know science was this much fun or this creative." Biochemical research can be fascinating because people conducting studies in this area are working to learn just how the human body works, and ultimately how to prevent and cure diseases like cancer.

Terry likes to spend her spare time with her husband and five children. Her husband makes pottery, and Terry enjoys going with him to sell his pots at craft fairs. Other favorite things Terry likes to do are hiking, cross-country skiing, swimming, reading, and going to the theater—especially the ballet.

Handout

Carol—Computer Scientist

Carol is a computer scientist who writes guidance programs for satellites. Carol's job is fun and exciting because the programs she and her coworkers develop are used to guide some of the satellites we send to explore the planets in our solar system. Several unique scientific studies are currently being planned.

The computer program that directs the satellite is called its guidance system. The program lets people at satellite command stations track the satellite at all times. It also lets them make changes in the vehicle's direction and speed and guide it to wherever it's supposed to go. Carol's programs are very carefully worked out and tested on a special computer to see if they are correct.

To develop satellite guidance programs, Carol needs to understand complex mathematics. Math has always been fun for Carol; when she was in high school and college she studied lots of math. After graduating from college, she obtained a master's degree in applied mathematics and computer science. Applied mathematics is the branch of math that deals with using advanced math to solve real-world problems.

Besides her enjoyment of mathematics and working with computers, Carol has several hobbies. She loves sports and the out-of-doors. She likes to go hiking, swimming, scuba diving, and jogging with her friends. She also enjoys stitchery and reading. In a few months, Carol is going to be married. She is looking forward to next year when she will begin working on a program to guide satellites in exploring the planet Mars.

Handout

Diana—Soil Scientist

Diana has a "dirty job." Diana works at a university, where she directs a research project on soil nutrients in pine forests. She and her research team study the soil around pine trees to discover how it provides nourishment to the trees. Pines obtain nutrients through their root systems, from the soil. Diana is especially interested in soil fertility.

When a pine needle drops from a tree, it contains vital nutrients. These nutrients—nitrogen, iron, and phosphorus—are absorbed into the soil as the needle decays. To determine the nutrient content of various soils, Diana and her research team have to collect samples of dirt from forests, then analyze them in their laboratory. They mix chemicals into the samples and analyze the results. To make her job easier, Diana uses a computer to study the soil samples.

Diana's work is very important because it helps foresters determine the portions of forests where trees can be logged and how long it will take for reforestation. To become a soil scientist, Diana studied math and chemistry in college; she has always enjoyed learning these subjects. After graduating from college she continued her studies and obtained a master's degree in soil science.

Although Diana really enjoys her job, she also likes to spend time with her family, especially water skiing and playing racket ball. She also makes pottery in her spare time.

Handout

Jenny—High School Math Teacher

Jenny loves to learn about mathematics and to help other people learn about it. She teaches math and computer programming at a large high school and is chair of the math department there. She has been selected as an outstanding teacher, and she also occasionally teaches workshops for other math teachers.

Jenny has been teaching math for ten years. She has taught just about every high school class you can take in mathematics and in computers. Her favorites are algebra, trigonometry, and advanced computer programming. In algebra, students learn to solve all kinds of problems in new and interesting ways; in trigonometry, which is called "trig" for short, they learn how to use angles and shapes to solve problems. Both of these subjects are very useful in many technical and science-related occupations. Advanced computer programing is also a very interesting subject that is currently being required in more careers. Jenny especially enjoys learning more about her own computer.

The thing that Jenny likes best about mathematics is the fun of using it to figure out how to solve a problem that she couldn't solve before. When you learn about arithmetic in grade school and junior high, it sometimes seems like mathematics is made up of unchanging rules. But when you get to advanced mathematics in high school and college, you see that people are still discovering new things about numbers and new answers to questions. Jenny also enjoys this "new discoveries" part of mathematics.

To become a mathematics teacher, Jenny studied all the math she could in high school and college. She got a bachelor's degree in mathematics and a master's in teaching.

Besides mathematics, Jenny enjoys many leisure activities. She likes playing tennis and going on long walks with her husband. She enjoys doing needlework and reading science fiction. One of her favorite pastimes is playing video games.

Resources

Askew, J. 1982. *The sky's the limit in math-related careers.* Newton MA: Women's Educational Equity Act Publishing Center/EDC.

This interesting book describes contemporary women in highly math-related occupations. Each of the chapters—computers, engineering, finance, math education, research mathematics, and statistics—includes several pictures and quotes from women about their jobs and the satisfaction they receive from them. Content is suitable for upper elementary, junior high, and high school students.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. The purpose of the program is ultimately to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes sections with activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction.

Koltnow, J. 1980. *Expanding your horizons in science and mathematics.* Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

This booklet is a guide to planning and conducting conferences for seventh through twelfth grade girls on math/science careers for girls. The conference format includes talks by role models and hands-on math and science activities for the girls attending.

Kreinberg, N., ed. 1977. *I'm madly in love with electricity and other comments about their work by women in science and engineering.* Berkeley: University of California, Lawrence Hall of Science.

This interesting and inspiring book includes selected comments about their work from women scientists, engineers, and mathematicians. Comments are organized into sections about careers in math, engineering, physics, astronomy, chemistry, and life sciences.

Osen, L. M. 1974. *Women in mathematics.* Cambridge: MIT Press.

This book was written to give students a historical perspective about women in math. Many myths about women in math are exposed, and women's aspirations for mathematical careers are encouraged.

Perl, T. H. 1978. *Math equals: Biographies of women mathematicians and related activities.* Menlo Park, CA: Addison-Wesley.

Math equals is a teacher resource on the history of women in math and science. The book contains biographies of the lives and work of nine famous women, plus interesting math activities related to the area of mathematics in which each of the women worked.

Perl, T. H.; Manning, J.; and Christner, P. 1981. *Women, numbers and dreams* (*Teacher's manual* and *Activity workbook*). Santa Rosa, CA: National Women's History Project.

This cleverly written workbook includes biographical sketches of famous female mathematicians along with mathematical activities appropriate for students in grades 3–9. The teacher's manual includes suggestions for incorporating these materials into the classroom and suggests ways to use the stories as role playing activities.

Part 3

The Learning Environment

This section of the guide contains suggestions that will help you

1. assess and increase your equitable teacher-student interaction patterns
2. encourage cooperative rather than competitive learning
3. implement an effort-persistence-mastery approach to problem solving
4. encourage independent thinking and creative learning of mathematics

Increasing Equitable Teacher-Student Interaction Patterns

We know from the findings of many research studies that even though most teachers believe they are completely fair and nonbiased in their treatment of students in the classroom, major differences do exist in the way they interact with girls and boys. Teachers are almost always completely unaware that they may be treating girls and boys differently. [illegible] they may have different expectations for each gender. The results of these differential teacher treatments and expectations can lead to girls performing at a lower level than boys.

- Teachers allow boys more time to answer questions (Gore and Roumagoux 1983), and they give boys more detailed explanations and feedback. (Webb 1981)

- Teachers are more likely to give extended directions to male students and to require them to complete a task or solve a problem; they tend to complete tasks or provide answers for females. (Sadker and Sadker 1985)

- Boys predominate in the classroom—they volunteer more answers, are likely to receive more teacher attention—both positive and negative—more praise, and more detailed instruction; even "aware" teachers fail to notice these differences. (Sadker and Sadker 1985; Morse and Handley 1982)

- Teachers seem to expect less of female students (Cartledge 1984), and they are less likely to recognize mathematical talent in girls than in boys. (Fox 1982)

- At all levels—from elementary to postsecondary—males receive more teacher interactions than females (Thomas 1983); high achieving high school boys receive significantly more attention in mathematics than any other group. (Good et al., cited in Fox et al. 1980)

- Teachers ask twice as many higher order questions of boys than of girls, and boys receive more feedback and more teacher-initiated help. (Cartledge 1984)

- Some teachers segregate students into single-sex groups; others do nothing to interfere when boys and girls segregate themselves—some even encourage this separation. (Grayson and Martin 1988)

- Students in gender-segregated groups often emphasize different values and roles. Girls value popularity and sweetness, while undervaluing academic performance; boys are more interested in being strong and performing well academically. (Fox, cited in Grayson and Martin 1988)

- Boys typically receive more criticism and stronger disciplinary action from teachers than do girls. (Grayson and Martin 1988)

- In selecting college majors, teachers' influence is more important for girls than for boys. (Ware and Lee 1985)

There are several reasons why even teachers with strong desires to treat all students fairly may inadvertently practice sex bias in the classroom. The rapid pace of interactions taking place during instruction makes it difficult for a teacher to attend to subtle classroom dynamics. Also, boys are much more assertive in school—they are eight times more likely to shout out answers and capture their teachers' attention. However, teachers often encourage this behavior—when boys shout out, teachers acknowledge them; but when girls shout out, teachers typically reprimand them and ask them to raise their hands if they want to be called on (Sadker and Sadker 1985). Research findings indicate that students do notice differences in the ways teachers treat members of each gender, and that this differential treatment can have subtle, although unintentional, negative consequences for girls (Grayson and Martin 1988). Teachers' attitudes, expectations, and treatment of students definitely affect students' confidence, aspirations, and other mathematics-related attitudes. The following activities, designed for teachers only, were developed to help you know your own interaction patterns and give you some suggestions to help you modify them, where appropriate.

Taken together, the activities in the following section seem quite redundant. There is a reason for this. The activities are listed in order from general self-examination processes dealing with classroom organization and teacher attitudes to peer group observation of your actual teaching behaviors. We believe that most teachers may first want to go through a self-examination of their interaction patterns with students. After the initial evaluation, many may desire to see themselves through video and examine their interaction styles in more detail; others will want to obtain feedback from other teachers and to compare notes on the problems of managing an equitable classroom. Completing this latter activity will probably require cooperation from your school principal. The activities should *never* be used in a judgmental evaluation context. Use the following activities as a guide to help you improve your interaction patterns.

Activity

Self-Examination of Teacher-Student Relationships in the Classroom

Objective To help you begin to think about your typical relationship patterns with students

Grade Level For teachers of all grades and all subjects

Time 30–60 minutes

Materials Questions below

Procedure Keep a journal (or copy the following) to wı .e down your observations of interactions with students. Answer the following questions:

1. Do you plan different activities or different roles within an activity for boys and for girls? How are they different?

2. Are the examples you use in classroom discussions or teaching situations mostly male or female? Do you stick with examples that show women and girls in traditional rather than nontraditional roles?

3. Whom do you ask to perform heavy chores in the classroom, males or females?

4. Whom do you ask to do secretarial chores and special tasks, males or females?

5. Do you define, up front, which behaviors are acceptable in your class and which are unacceptable? Are they the same for girls and boys?

6. What are your behavioral expectations for the girls in your class? Are these different from your expectations for the boys?

7. Do you display affection and displeasure in the same way toward girls and boys?

8. Do you censure girls and boys for different behaviors? What behaviors?

9. Do you punish girls and boys for different things? Do you punish them differently? How?

10. Do you reward boys and girls for different things? Do your methods of reward differ?

Activity

Teacher's Self-Evaluation of Nonsexist Behavior in the Classroom

Objective

To help you examine your classroom behavior in four areas related to equitable instruction and identify possible unconscious sexist behaviors in dealing with students

Grade Level

For teachers of all grades

Time

30 minutes to 1 hour

Materials

"Teacher's Self-Evaluation of Nonsexist Behavior in the Math Classroom" checklist on the following pages

Procedure

It is important that this checklist be used as an exercise to create personal growth and awareness and *not be used in a judgmental way.*

To use this checklist, rate yourself on each of the following four areas:

1. Teacher's behavior
2. Interactions with others
3. Instructional tasks
4. Extracurricular activities

At the end of each section, review your ratings and evaluate your overall performance by marking the continuum.

After checking for areas of weakness as indicated by your ratings, state your specific goals for becoming more sex fair.

Worksheet

Teacher's Self-Evaluation of Nonsexist Behavior in the Math Classroom

Teacher's Behavior	Always	Often	Sometimes	Never	N/A
1. *Attitude.* I take the idea of equality seriously; for example, I do not put down men or women or joke about their math abilities.	____	____	____	____	____
2. *Language.* I use nonsexist language; in other words, I do not refer to all scientists or mathematicians as "he" or all nurses or secretaries as "she."	____	____	____	____	____
3. *Generalizations.* I avoid generalizations that refer to sex stereotyping in math; for example, "You think like a woman" or "You solve problems like a man."	____	____	____	____	____
4. *Types of examples.* I use examples in my teaching showing both men and women with a wide range of feelings, interests, and career choices. I include examples of women in highly math-related career areas.	____	____	____	____	____
5. *Facts.* I display and use accurate factual knowledge about the current economic and legal status of women and men of all races.	____	____	____	____	____
6. *Supplementary materials used.* I supplement inadequate treatment of either sex in classroom materials by adding information or by discussing the accurate portrayal of people's roles.	____	____	____	____	____
7. *Comparisons.* I avoid comparison of students based on gender; for example, I would not say, "The girls are working harder than the boys."	____	____	____	____	____
8. *Equal attention.* I give equal attention to boys and girls; I do not show preference for one sex over the other.	____	____	____	____	____
9. *Discipline.* I discipline both sexes in the same way.	____	____	____	____	____

	Always	Often	Sometimes	Never	N/A
10. *Values.* I reinforce students' expression of values without regard to their sex, so that both boys and girls can express assertiveness and gentleness.	____	____	____	____	____
11. *Vocational interests.* I help students explore all vocational interests, not only those traditionally associated with their sex.	____	____	____	____	____
12. *Model.* I act as a model of nonsexist behavior by performing activities traditionally thought to be more easily done by the opposite sex; for example, if female, I run AV equipment, lift boxes, and express a strong interest in mathematics; if male, I perform clerical duties and dust shelves.	____	____	____	____	____
13. *Grades.* My mathematics grading patterns do not favor boys or girls, but reflect individual accomplishments.	____	____	____	____	____
14. *Encouragement.* I encourage girls as well as boys to excel in mathematics and to pursue math-related careers.	____	____	____	____	____
15. *Beliefs about math.* I hold nonstereotypical beliefs about gender and math; that is, I do not believe that math is more difficult for girls than for boys, and I do not believe that math is more important for boys than for girls or that boys naturally do better at math and are more naturally interested in it.	____	____	____	____	____

Summary Rating

I model sex-fair behavior (actions and words) in the classroom. I convey to my students the importance of equality and the appropriateness for both sexes of a range of roles and interests.

Mark the continuum:

____

Basically sex fair	Need slight improvement	Need some improvement	Need much improvement

Consider how you rated yourself on teacher's behavior. List your specific goals for increasing sex-fair behavior.

- ____
- ____
- ____

Interactions with Others	Always	Often	Sometimes	Never	N/A
16. *Academic performance.* I expect equal academic performance from boys and girls; that is, girls are not assumed to be better in verbal skills and boys superior in math and science.	___	___	___	___	___
17. *Student interests.* I recognize that students may have interests not traditionally associated with their sex; I do not expect girls to have typically feminine interests and boys typically masculine interests. I expect girls to be very interested in math.	___	___	___	___	___
18. *Classroom behavior.* I expect the same behavior from girls and boys; for example, I do not expect chivalrous behavior only from boys, tolerate language (slang or swearing) from boys that girls may not use, or require neatness from girls and not from boys.	___	___	___	___	___
19. *Expression of emotions.* I permit all children to show their emotions without regard to sex (within the limitation of classroom rules).	___	___	___	___	___
20. *Nonsexist behavior.* I require students of both sexes to treat each other as equals; for example, I encourage students to include others of both sexes in all activities, and I do not allow the sexist remarks of students to go continually unchallenged.	___	___	___	___	___

Summary Rating

I have the same academic and behavioral expectations for boys and girls, I acknowledge the acceptability of the same emotions and interests in boys and girls.

Mark the continuum:

Basically sex fair	Need slight improvement	Need some improvement	Need much improvement

Consider your ratings on interactions with others. List your specific goals for increasing sex-fair behavior.

- ______________________________
- ______________________________
- ______________________________

Instructional Tasks	Always	Often	Sometimes	Never	N/A
21. *Bulletin boards.* All visual materials in my classroom are nonsexist and nonracist, showing men and women in a variety of roles that reflect the many interests of boys and girls.	____	____	____	____	____
22. *Supplementary materials available.* When the treatment of either men or women is inadequate in a textbook, I have supplementary materials readily available to students; for example, reference books about significant women in history or science or family-living books that explain the role of a father.	____	____	____	____	____
23. *Dividing students.* I avoid dividing or grouping students on the basis of sex, for example, in lunch lines, in seating, or for academic or athletic competition.	____	____	____	____	____
24. *Activities and assignments.* I recommend all classroom activities to both boys and girls; for example, I suggest both boys and girls try cooking or woodworking as optional activities.	____	____	____	____	____
25. *Classroom duties.* I assign classroom chores and duties without regard to sex; for example, both boys and girls carry chairs, run AV equipment, take notes during classroom meetings, and water plants.	____	____	____	____	____

Summary Rating

I plan classroom activities so that gender is not a criterion for organization; the classroom environment gives girls and boys the same kind of educational experience.

Mark the continuum:

____

Basically sex fair	Need slight improvement	Need some improvement	Need much improvement

Consider how you rated yourself on instructional tasks. List your specific goals for increasing sex-fair behavior.

- ____
- ____
- ____

Extracurricular Activities	Always	Often	Sometimes	Never	N/A
26. *Availability of facilities, equipment, and clubs.* I make all school facilities, equipment, and clubs equally available to all students.	____	____	____	____	____
27. *Recognition of achievement.* I give equal attention to the extracurricular achievements of boys and girls; for example, I acknowledge the athletic achievement of both sexes.	____	____	____	____	____
28. *Service projects.* I suggest that both girls and boys work on service projects.	____	____	____	____	____
29. *Participation in extracurricular activities.* I encourage boys and girls to participate in all extracurricular activities, for example, sports, cheerleading, library club, stage crew, etc.	____	____	____	____	____
30. *Roles in extracurricular activities.* I encourage boys and girls to participate in a variety of roles within extracurricular activities, for example, committee head, hospitality committee, secretary, treasurer, president, etc.	____	____	____	____	____

Summary Rating

I give boys and girls equal recognition and encouragement in extracurricular activities.

Mark the continuum:

Basically sex fair	Need slight improvement	Need some improvement	Need much improvement

Consider your ratings on extracurricular activities. List your specific goals for increasing sex-fair behavior.

- ____________________
- ____________________
- ____________________

Activity

Assessing Your Active Teaching Attention Patterns

Objective

To make you aware of potential inequities in your active teaching attention to girls and boys in the classroom

Grade Level

For teachers of all grades and all subjects

Time

10–20 minute observation period, plus 20–30 minutes for data summary

Materials

Assessment and summary sheets on following pages, stopwatch

Procedure

Ask a colleague to observe your classes while you are questioning and giving directions to students and fill in the assessment sheet for active teaching attention patterns. Then, using the data gathered, answer the questions on the summary page about your own active teaching attention patterns.

Variation

Have your class video- or audiotaped. Then playback the tape, and use the assessment sheet to evaluate your own teaching behavior.

Strategies to Improve Active Teaching Attention

1. Circulate around the room after math assignment has begun. Position yourself in different areas to influence the degree of involvement of both girls and boys.

2. Make a conscious effort to encourage equal participation of girls and boys in math.

3. Distribute both lower order and higher order questions to girls and boys on an equitable basis.

4. Measure your wait time to ensure an equal distribution for girls and boys.

5. Distribute the same types of reinforcement to both girls and boys.

6. Give extended directions to girls and boys on an equitable basis; provide extensive directions so girls and boys can complete tasks independently, and avoid doing or completing tasks for students.

Items 1–6 were adapted from *Sex equity handbook for schools* by Myra and David Sadker.

Some Ways to Keep Track of Your Questioning Patterns

1. Use a student-kept checklist of questioning patterns. Each day for a week have a *different* student keep a tally of which students are called on to answer questions.

2. Have copies of your class seating chart nearby when giving a lesson. Place a check next to each student called on to answer a question.

3. Students in front get called on the most. Rearrange your seating frequently, and move around. Ask questions from different parts of the room. Stand near those students who don't speak up in class.

4. Have every student's name on a 3" x 5" card. Shuffle the "deck," and draw to select students to answer questions.

5. Give every student a card with a distinguishable front and back. Each student who is called on turns over his or her card. Each student who is given a second response opportunity turns in her or his card. At the end of the period, check to see how many students still have cards upright, how many cards are turned over, and how many cards have been turned in. Is there a pattern?

Worksheet

Assessment Sheet: Focus on Active Teaching Attention

Record examples of classroom interactions involving teacher questioning and student response. In column 1: Teacher Question, check whether the question was a higher order question (HOQ) or lower order question (LOQ). A higher order question is one that requires the student to integrate material or to use a more complex mental process; a lower order question can be answered with simple recall. In column 2: Wait Time, measure the length of wait time given male and female students to answer each question. Count the time the teacher pauses before providing hints or going to another student. In column 3: Student Responding, indicate whether a girl or boy answered the question. In column 4: Teacher Reaction, indicate the teacher's reaction to the student's response (e.g., praise, criticism, ignoring, a simple "OK," and so on). Try to fill in at least 25 interactions. Also, look for examples where the teacher gives directions to students, and note the completeness of the instructions, sex of the student, and whether or not the teacher completes tasks for students of each sex.

(1) Teacher Question		(2) Wait Time	(3) Student Responding		(4) Teacher Reaction
HOQ	LOQ		Girl	Boy	

Examples of teacher's directions to girls and boys:

Worksheet

Summary of Information on Active Teaching Attention

	Frequently	Sometimes	Never
1. As a result of the data gathered in the chart, what are your conclusions on the following questions?			
a. Do you ask an equitable number of LOQs of female and male students?	______	______	______
b. Do you ask an equitable number of HOQs of male and female students?	______	______	______
c. Do you reinforce female and male students on an equitable basis?	______	______	______
d. Do you give an equitable amount of wait time to female and male students?			
2. Do you give extended directions to both boys and girls on an equitable basis so that they can complete tasks independently? Examples:	______	______	______
3. Do you complete tasks for girls and boys instead of instructing so they may complete work independently? Examples:	______	______	______

4. What other strategies could you use to attain sex equity in active teaching attention?
Examples and comment:

Activity

Assessing the Extent of Sex Segregation in Your Classroom

Objective

To make you aware of the ways that students may be segregated in your classroom and who initiates this pattern, i.e., teacher, students, or others

Grade Level

For teachers of all grades

Time

Four 5-minute observation periods, plus 20 minutes for data summary

Materials

Assessment and summary sheets on the following pages

Procedure

Ask a colleague to observe your classes and fill in the assessment sheet focusing on sex-segregation patterns. Then, using the information gathered, answer the questions about your own classroom on the summary page.

Variation

Have your class video- or audiotaped. Then playback the tape, and use the assessment sheet to evaluate your own classroom.

Strategies for Encouraging Better Integration in the Classroom

1. When students are being seated or are lining up, use categories other than sex to divide the class (see resource list at the end of this section for suggestions). For example, you might seat alphabetically, rotating this seating periodically to give all students a chance to sit in the front of the room. You might line up by age (those over or under a certain age form two lines), colors worn, first letter of last name, month of birth, etc.
2. Avoid sex-segregated activity areas.
3. When students self-segregate in their own activities, it may be necessary to form a new organizational pattern to achieve classroom integration.
4. Encourage girls and boys to participate in traditional and nontraditional activities. For example, encourage girls to be active in typically male sports and games. Encourage boys to be active in typically female sports and games.
5. If students are uncomfortable with nonstereotyped assignments, discuss the issue of sex stereotyping and today's changing roles for women and men.
6. Make a conscious effort to assign leadership and support roles to both boys and girls.

7. Encourage and reinforce girls and boys who are working and interacting cooperatively.

Worksheet

Assessment Sheet: Focus on Sex Segregation

Record examples of sex segregation and integration in the classroom. In column 1. Sex Segregated/Integrated, indicate whether each area is segregated or integrated on the basis of sex. In column 2. Source, check the source that initiated each organizational pattern—the teacher, the student, or other (e.g., school policy, ability grouping, and so on). In column 3: Examples, give specific examples for each organizational pattern (e.g., seating charts, descriptions of segregated or integrated lines and groups, and so on).

Classroom Organization	(1) Sex Segregated/Integrated	(2) Source	(3) Examples
Seating patterns			
		teacher ____________	
		student ____________	
		other ____________	
Lining-up procedures			
		teacher ____________	
		student ____________	
		other ____________	
Work/activity groups			
		teacher ____________	
		student ____________	
		other ____________	

Adapted from *Sex equity handbook for schools* by Myra and David Sadker. Copyright 1980 by Myra and David Sadker, American University, Washington, D.C. Used by permission.

Worksheet

Summary of Information on Classroom Sex Segregation Patterns

	Frequently	Sometimes	Never
1. As a result of the data gathered in the chart, what areas of classroom organization (seating, lining up, group work) need further work to promote sex integration? Give examples:	____	____	____
2. Are "helping" tasks stereotyped on the basis of sex? (Examples: boys carry books, girls collect lunch money) Examples:	____	____	____
3. If and when sex segregation occurred, was there an intervention that encouraged integrated work or free activity groupings? Examples:	____	____	____
4. Is there reinforcement for girls and boys who work together on classroom activities? (Examples: "Mary and Jeff, you two did a fine job on your group report" or "Randy and Becky, you really helped your team win the game.") Examples:	____	____	____

5. What other strategies do/could you use to attain sex integration in classroom organization and activities?
Examples and comment:

Activity

Assessing Your Classroom Discipline Patterns

Objective To make you aware of potential gender inequities in your classroom discipline patterns

Grade Level For teachers of all grades

Time 20–30 minute observation period, plus 20 minutes for data summary

Materials Assessment and summary sheets on the following pages

Procedure Ask a colleague to observe your classes (or videotape your classes) and fill in the assessment sheet for classroom discipline patterns. Then, using the information gathered, answer the questions about your own classroom discipline patterns on the summary page.

Strategies for Eliminating Sex Bias in Classroom Discipline

1. Avoid stereotyping girls as passive and obedient and boys as aggressive and disruptive.

2. Give reprimands according to the misbehavior and not on the basis of sex.

3. Relate penalties or punishments to the infraction; don't apply on the basis of sex.

Worksheet

Assessment Sheet: Focus on Classroom Discipline Patterns

Record examples of student misbehavior and teacher disciplinary reaction. In column 1: Sex of Student, list the sex of the student involved in inappropriate classroom behavior. In column 2: Student Misbehavior, describe the type of misconduct (e.g., talking, leaving seat, and so on). In column 3: Reprimand, if given, indicate whether the teacher offered the rebuke in a harsh or soft, public or private manner. In column 4: Penalty, record the nature of any penalty assigned (e.g., detention, sent to office, and so on). In column 5: No Disciplinary Action, put a check mark if the teacher did not reprimand or penalize the student who was misbehaving.

(1) Sex of Student	(2) Student Misbehavior	(3) Reprimand	(4) Penalty	(5) No Disciplinary Action

Adapted from *Sex equity handbook for schools* by Myra and David Sadker. Copyright 1980 by Myra and David Sadker, American University, Washington, D.C. Used by permission.

Worksheet

Summary of Information on Classroom Discipline

	Frequently	Sometimes	Never
1. As a result of the data gathered in the chart:			
a. Do you hold girls and boys to the same standards of classroom conduct? Examples and comment:	______	______	______
b. Do you dispense disciplinary action to boys and girls on a fair and equitable basis? Examples and comment:	______	______	______
2. Are equitable classroom management strategies used to avoid teacher-student confrontations that interrupt learning (e.g., nonverbal behaviors, proximity control, and so on)? Examples and comment:	______	______	______

3. What other management strategies could you use to avoid teacher-student confrontations and to attain sex equity in discipline for boys and girls?
Examples and comment:

Activity

Assessing Your Classroom Verbal Evaluation Patterns

Objective To make you aware of potential inequities in your verbal evaluation patterns

Grade Level For teachers of all grades

Time 30-minute observation period, plus 20 minutes for data summary

Materials Assessment and summary sheets on the following pages

Procedure Ask a colleague to observe your class and fill in the assessment sheet for verbal evaluation patterns. Then, using the information gathered, answer the questions on the summary page.

Strategies for Ensuring Sex Fair Verbal Evaluation:

1. Avoid stereotyping girls as excelling in neatness and boys as excelling in academic endeavors.

2. Distribute praise for academic work to girls and boys on a fair and equitable basis.

3. Identify both boys and girls whose academic work reflects neatness and conforms to rules of form.

4. Identify both boys and girls whose academic work reflects intellectual competence.

5. Offer remediation comments on verbal or written work that does not meet standards of form or intellectual quality to both girls and boys. Make sure students clearly understand the nature of the inadequacy and how to correct it. Encourage both boys and girls to try harder or to try another approach. Without this encouragement, students may think they do not have the ability and may simply give up.

Worksheet

Assessment Sheet: Focus on Verbal Evaluation of Academic Work

Use the following chart to list all instances of teacher praise or criticism in response to student verbal or written academic work. In column 1: Sex of Student, list the sex of the student being praised or criticized. In column 2: Praise, check whether praise is given for the intellectual quality of the student's ideas and comments or for the correctness of form/appearance of the student's written work. In column 3: Criticism, check whether criticism is given for student ideas and comments that fail to meet standards of intellectual quality or for student written work that fails to meet standards of form, neatness, and appearance.

(1)	(2) Praise		(3) Criticism	
Sex of Student	Student Ideas/Comments	Form/Appearance of Written Work	Student Ideas/Comments	Form/Appearance of Academic Work

Worksheet

Summary of Information on Verbal Evaluation Patterns

	Frequently	Sometimes	Never
1. Using the data gathered on the chart:			
a. Do you praise girls and boys on an equitable basis for the intellectual quality of their written and verbal work? Examples and comment:	______	______	______
b. Do you praise boys and girls on an equitable basis for the appearance, form, and neatness of their written work? Examples and comment:	______	______	______
c. Do you criticize girls and boys on an equitable basis concerning the intellectual quality of their written and verbal work? Examples and comment:	______	______	______
d. Do you criticize boys and girls on an equitable basis for written work that fails to meet standards of form, neatness, and appearance? Examples and comment:	______	______	______
2. Do you encourage both girls and boys to try harder so they will be more likely to attribute failure to insufficient effort rather than to lack of ability? Examples and comment:	______	______	______

3. What other strategies do/could you use to attain sex equity in the verbal evaluation of academic work?
Examples and comment:

Activity

GESA—Gender/Ethnic Expectations and Student Achievement

Objective To provide you with specific feedback about your interaction patterns with students

Grade Level For teachers of all grades

Time Five 30-minute observation periods, plus 20 minutes for data summary for each period

Materials "GESA Observation Report" coding sheet and instructions on the following pages

Procedure GESA program staff have found the following ten items to be the major areas of gender disparity in teaching:

Response opportunities
Acknowledgment/feedback
Wait time
Physical closeness
Touching
Reproof—verbal or nonverbal indication that a student's behavior is not acceptable
Probing
Listening
Higher level questioning
Analytical feedback

To identify these interactions, GESA designed the "GESA Observation Report" (see following pages). This form is meant to be used by one or more peer observers in your classroom. Any two of the ten areas listed above can be observed and coded at any given session. The report allows the observer to tally the occurrences of the two chosen interaction areas for the entire class of students. Instructions for filling out the form are included on the following pages. After an observation period, each teacher analyzes the data from her or his classroom to determine any patterns of gender disparity. Teachers who have used the GESA training in their classrooms have noticeably decreased gender bias in teacher-student interactions. For further information about the GESA program and to arrange for GESA training, contact the GrayMill Foundation (see resource list at the end of this section).

The GESA program is best carried out with training; however these materials have been included to show you what the program is like. Find one or more peers who also wish to take part in the program. You will take turns observing each others' class for a number of 30-minute periods (usually five or more).

Read the coding instructions that follow the attached form, and make sure that all observers agree on how responses will be coded. Make several copies of observation form. Label *a* and *b* the interactions you will be observing; for example, you might choose to observe "listening" and "probing." Write down students names and prepare a class seating chart. You may code up to four observations for each interaction with a student.

All observation periods should be scheduled in advance, and all teachers should know which interactions are being observed. To facilitate the observation, teachers being observed should use student names as much as possible.

To code the observation, make a slash mark by a student's name only when the teacher uses one of the strategies being observed.

Variation

You may wish to conduct a preliminary observation of each of the ten areas, then reobserve several weeks later.

Worksheet

GESA Observation Report

Interactions: a ______________ b ______________ Class ______________

Student No.	Sex	First Name	Eth.	Obs. 1		Obs. 2		Obs. 3		Obs. 4		TOTAL	
				a	b	a	b	a	b	a	b	a	b
01													
02													
03													
04													
05													
06													
07													
08													
09													
10													
11													
12													
13													
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36													
37													
38													
39													
40													

Female - 1; Male - 2

Handout

Coding Instructions

Coding Response Opportunities

The observer codes one response opportunity when the teacher calls on a student to answer a question; accepts the answer of a student who calls out a response to the teacher's question, or calls on a student to perform in some other way before the class or a small group. For example, the student could be asked to read aloud, work a problem on the board, give a report, or express an opinion.

Do not code response opportunities that are not part of the instructional process, e.g., "Are you cold, George?"

Coding Acknowledgment/Feedback

The observer codes acknowledgment or feedback when the teacher affirms, praises, corrects, criticizes, or rejects a student's response or performance. The key characteristic of feedback is that the student receives helpful information. The feedback says, in effect, you are on the right track or you need to make modifications.

Code only feedback that is clearly directed to one or several students—not to the entire class.

Code only feedback that relates to the instructional task. Do not code feedback related to a student's posture, appearance, decorum, etc.

Coding Wait Time

Wait time is coded each time the teacher waits at least five seconds before terminating the response opportunity (usually by asking another student the same question) or providing additional information or hints.

Coding Physical Closeness

Nothing is coded if the teacher merely walks by a student. When the teacher stands or sits somewhere in the classroom physical closeness is recorded for each student within arms reach.

If a student approaches the teacher and some instructional business is transacted within arms reach, physical closeness is recorded. If the teacher remains near one or more students during the entire observation, physical closeness is recorded only once for each student. If the teacher leaves those students and later returns, physical closeness is recorded again. In other words, the initiation of the physical closeness is recorded, not the duration.

Coding Reproof

The observer records reproof when the teacher, unemotionally and respectfully, asks the student to stop behaving inappropriately. The student may or may not change the behavior. If the teacher later repeats the same request, a second reproof is recorded. Reproof may be nonverbal.

Coding Touching

Touching is recorded when the teacher's hand contacts the student in a way that expresses helpfulness, encouragement, regard, or affection.

Touching is not recorded if the teacher touches the student angrily or to punish.

Touching is not recorded if the teacher touches the student with a pencil, ruler, or other object, even if this is a friendly gesture.

Coding Probing

The observer records probing when the teacher provides additional information to assist a student who is having difficulty responding.

Coding Listening

The observer codes listening when the teacher's attention to a student's question, response, or comment is apparent. Attentiveness may be indicated by the teacher's expression, gestures, or verbal response.

Coding Higher Level Questions

The observer records a higher level question when the teacher asks a question that requires a more complex mental process than simple recall. Everything that the teacher says to help the student understand the question is recorded as only one question.

Only those questions that are intended to be answered by students during the instructional period are recorded. Do not record hypothetical questions or questions that are part of homework assignments.

Coding Analytical Feedback

The observer records analytical feedback each time the teacher explains in a supportive way why a student's performance was or was not acceptable. The feedback must be helpful to the learning process. Feedback that does not deal with the learning content, but is directed at the student's attitude, appearance, or deportment is not recorded. If you cannot decide whether the feedback was positive and helpful, code nothing.

Activity

How to Reduce or Eliminate Sex-Role Socialization Effects

Objective To help you think about steps you can take to counteract the effects of sex-role socialization

Grade Level For teachers of all grades

Time Variable

Materials Statements and questions below

Procedure Some of the effects of sex-role stereotyping have been listed below. In the space provided, list some of the things you, as an educator, can do or say to reduce these effects on achievement.

Effect: Girls have fewer opportunities than boys to develop leadership skills.

How to reduce:

Effect: Boys are given more encouragement and rewards for achieving good math grades than girls.

How to reduce:

Effect: Boys tend to overestimate their level of math achievement; girls tend to underestimate theirs.

How to reduce:

Variation Use this as a discussion activity with (a) other math teachers, (b) counselors, or (c) students.

Resources

Campbell, P. B. 1986. "What's a nice girl like you doing in a math class?" *Phi Delta Kappan* 67, no. 7: 516–20.

This is an excellent summary article that describes sex differences in mathematics achievement and career choices, differential treatment and expectations, and effective programs for promoting equity in math education.

deNys, M., and Wolfe, L. 1985. *PEER report: Learning her place—sex bias in the elementary school classroom.* Washington, DC: NOW Legal Defense and Education Fund.

An excellent summary of information on differential expectations and treatment of girls and boys in the classroom, with suggestions for teachers and parents. Although some of the content of the report is focused on elementary schools, its conclusions and recommendations are also appropriate for junior high classrooms.

Grayson, D., and Martin, M. 1988. *Gender/ethnic expectations and student achievement: Teacher handbook.* Earlham, IA: GrayMill Foundation.

This manual accompanies the GESA training program. It contains a number of activities and exercises for teachers, plus explanatory information about the program.

Kaser, J. S. 1985. *Count me in! Guidelines for enhancing participation in mixed gender work groups.* Washington, DC: The Mid-Atlantic Center for Sex Equity.

This booklet includes guidelines for enhancing participation in mixed gender work groups. The suggestions can be very helpful for educators, since much of the school day involves group interaction.

Mid-Atlantic C[illegible] for Sex Equity. n.d. *101 ways to line up.* Poster. Washington, DC: Ame[illegible] University.

This poster suggests many ways that males and females may be grouped to enhance mixed gender interaction.

Sadker, M., and Sadker, D. 1980. *Sex equity handbook for schools.* Washington, DC: American University, Mid-Atlantic Center for Sex Equity.

This book reviews research on sexism in schools and provides hands-on classroom activities for teachers to counteract the effects of sexism in the classroom.

Encouraging Cooperative Learning

Our educational system was originally designed to meet the needs of male students. Many classroom activities and procedures emphasize competitive techniques, which have traditionally been thought to be more appropriate for the male learning style. However, recent studies have shown that most children learn more readily in cooperative situations. Competitiveness can interfere with learning because it (1) makes students anxious and interferes with their concentration, (2) doesn't permit them to share talents and learn from each other as easily, and (3) distracts them from what they are doing—they concentrate on the reward or on winning instead of on what they are learning. Evidence also indicates that girls learn more readily in cooperative situations that emphasize working with others and discussing how to solve problems.

- Of 109 studies conducted between 1924 and 1980 comparing competitive and cooperative learning, 60 percent found that students achieve higher levels when they work cooperatively as opposed to competitively. The reverse was true in only 7 percent, and no differences were found in one-third of the studies. The more complex the learning task, the worse children fared in a competitive environment. The superiority of cooperation was consistent for all academic subjects across all age groups. (Johnson, cited in Kohn 1986)

- In classes where boys and girls collaborate, sex stereotyping is reduced and girls display more positive self-esteem and are more apt to assume leadership roles. (Campbell 1984)

- In addition to its effects on student achievement, cooperative learning has also been found, in many studies, to have positive effects on students' self-esteem, peer group support for academic achievement, and liking for school. (Slavin 1983)

- Girls are more likely to continue studying math when their math classes are interactive and instructive. (Stallings 1985)

- Many teachers have been taught to use competitive instructional strategies in the classroom. These can work to the disadvantage of female students who may feel more comfortable and perform at a higher level in cooperative situations. (*Concerns* 1985; Peterson and Fennema 1985)

- Academic work is rarely organized to encourage student collaboration, particularly cross-sex collaboration. In one study, only about 11 percent of instructional time was devoted to mixed-sex groups. (Lockheed, cited in Grayson and Martin 1988)

- The math achievement of fourth-grade girls in both high- and low-level problem solving was found to be positively related to participation in cooperative mathematics activities and negatively related to participation in competitive math activities. For boys, the relationships were reversed. (Peterson and Fennema 1985)

Although students still have to work on their own in testing situations, cooperative learning has been shown, in most cases, to be a valuable experience for both boys and girls. The ideas on the following pages include suggestions for incorporating cooperative activities in your classes.

Strategies

The following are guidelines for creating a school environment that supports cooperative behavior:

1. Assign tasks on some basis other than gender. Every participant has resources useful to the group's problem-solving efforts.

2. Encourage females and males to sit next to each other.

3. Don't allow any single group member to dominate the group, activity, or the most desirable spaces in the group (e.g., head of the table).

4. Focus on the process of the cooperative activity. Recognize and share with students the results of cooperative efforts.

5. Expand the meaning of cooperation to include the whole school, families, neighborhoods, and workplaces.

6. Encourage students to study together—be aware of any learning group that forms naturally.

7. When leaders choose team members, make sure equal numbers of girls and boys are chosen for each team.

8. Possible barriers that sometimes hinder cooperative learning have been suggested by these research findings:

   a. Males are more likely to control discussion through introducing topics, interrupting, and talking more than females.

   b. Females talk less, often assume supportive rather than leadership roles in conversation, and receive less attention for their ideas from the group.

   c. Both males and females may expect group members to follow sex-stereotypic roles that can limit each individual's contributions (e.g., males will be leaders, females will be secretaries).

Overcome these potential barriers to cooperative learning by

a. adhering to strict rules of class behavior and using the same rules for boys and girls

b. placing girls in leadership roles and monitoring their performance

c. making students aware of stereotyping, expected roles, and how we are all free to choose and modify our roles

9. Some authors have suggested that if girls appear to have low confidence in their abilities, they need to be placed in single-sex groups to build confidence before joining mixed-sex groups.

10. Researchers have suggested several classroom cooperative techniques that can be adapted for teaching math. Some of theses techniques are listed on the following page. They include Math Teams Tournament, Student Teams—Achievement Divisions, Jigsaw, and small group teaching. Use the resource list to find suggestions for additional ways to structure cooperative math learning activities.

Principles for Structuring a Cooperative Learning Environment

Graves et al. list the following ten principles, along with ways to implement each in the classroom in Slavin et al. (1985):

Principles	*Implementation in the Classroom*
1. Establish a group identity with group unity and cohesiveness.	a. Use getting-acquainted activities.
	b. Create symbols for the group.
	c. Plan events that create unity experiences for the class.
2. Recognize, value, and incorporate the individuality and uniqueness of each student in the group.	a. Explain to students the contribution of individual differences to the whole.
	b. Help students learn about and understand others' family and cultural backgrounds.
	c. Invite persons of differing ages and backgrounds to visit your classroom and serve as role models.
3. Establish group norms and shared authority.	a. Let the class participate in establishing norms for cooperative interaction in the classroom.
	b. Provide a forum for discussing and settling conflict situations.
	c. Give all students practice in organizing and directing others and in being directed by others.
	d. Provide students practice in communication and conflict management.
4. Establish standards of individual responsibility, with roles and functions for everyone.	a. Cooperatively establish roles and functions needed in the classroom with students.
	b. Let students set up a rotating system, so all learn to participate in all roles and functions.

c. Distinguish between ongoing roles and special roles—balance participation.

d. Take advantage of special events to recognize and acknowledge individuals.

e. Occasionally participate in classroom chores and games along with students.

5. Demonstrate how everyone benefits from working together for common goals.

a. Relate individual goals to the goals of the group—be sure these do not conflict.

b. Discuss how each person contributes to and benefits from group goals.

c. Lead students to select group goals that are meaningful to them.

d. Regularly follow through with group goals and rewards.

e. Involve parents and community members in setting wider group goals for students in their neighborhoods and at home.

6. Develop intrinsic motivation—pleasure from rewards inherent in the activity; clarify the features of the activity that provide their own reward.

a. Avoid external rewards and incentives as much as possible.

b. Establish the importance of each activity as pleasurable in itself.

c. Make explicit the fun and interest inherent in working as a group.

d. Discuss the communication and empathic skills needed to make group work more fun.

e. Spend time afterwards celebrating what students enjoyed about an activity and what they learned in the process.

7. Learn what each member has that may be of value to someone else—exchange talents, skills, and services.

a. Have times set aside or special events where exchange and barter of physical objects and possessions are encouraged.

b. Discuss how to recognize what other people like, want, or need.

c. Set up a service exchange in the classroom where students can contribute what they are good at and receive a service they would like (e.g., math tutoring for spelling drill).

d. Have students with special skills or talents teach those skills to the rest of the class or to selected students.

e. Highlight special attributes, experience, or knowledge of each member of the class, so that students learn about what others have to contribute.

8. Find practical tasks for practicing cooperative skills; make academic tasks as obviously practical and relevant as possible.

a. Make "household chores" of the classroom occasions for cooperative effort.

b. Emphasize the cooperative nature of parties, field trips, and special events.

c. Tie cooperative efforts to group goals/needs; emphasize relevance.

d. Incorporate neighborhood, home, and community as much as practical and relevant into the class schedule as opportunities to learn cooperative skills.

e. Make practical and concrete outcomes important through public recognition of efforts.

f. Teach basic skills by applying them to relevant tasks for group goals, e.g., earning for classroom equipment.

9. Restructure space and material objects to promote cooperative interaction and sharing of materials and equipment in the classroom.

a. Arrange work spaces to suit the nature of the task: huddled for highly interactive tasks, spaced for individual concentration.

b. Gather the class together closely for class meetings, discussions, and planning sessions.

c. Have students work out systems for sharing scarce materials. Provide only the minimum amounts of materials necessary to encourage sharing.

d. Provide central places for keeping shared materials that are easily accessible to all students.

10. Establish connections between individual members in their joint efforts.

a. Practice appropriate interpersonal skills that encourage rather than put down others.

b. Incorporate experience with different types of cooperation: accumulation of individual efforts, coordination of joint efforts.

c. Discuss different types of cooperative efforts and the appropriateness of each; recognize that coordination requires more complex skills.

d. Place competitive behavior in an overall context that is cooperative—"reframe" competition.

e. Use intergroup competition only when cooperative patterns are well established.

Activity

Math Teams Tournaments (and other cooperative activities)

Objective

To allow students to experience cooperative learning, to learn and practice math skills

Grade Level

Grades 6–9

Math Concepts/Skills

Any, depending on class needs

Time

Blocks of 30–45 minutes per session (May also be used as a free-time activity and/or a continuing activity. You might want to schedule one per week or one per month.)

Materials

Teacher-generated study materials, quiz questions for tournaments

Procedure

This technique combines elements of both cooperation (the teams) and competition (the tournaments). The primary function of the teams is to prepare members to do well in the tournament. First explain the procedure to students, letting them know how the teams will function, and that all teams have an equal chance of winning—it depends on how well they prepare.

Assign students to *heterogeneous* groups of four or five members. Each group should include females and males who vary in ability level and ethnic origin.

Instruct student teams to prepare for math tournaments that will be held once each week (or whenever you decide). Give students worksheets covering the academic material to be included in the tournament; teammates study together and quiz each other to make sure that all are prepared.

For the tournament, assign students to groups of three with *homogeneous ability* at each tournament table; assign the top three students in past performance to one table, the next top three to another table, etc. For example, if your class has thirty students, you might have six 5-person teams and ten 3-person tournament tables. The Blue team's students might compete at tables 1, 3, 5, 8 and 10. The Red team's members might compete at tables 2, 4, 6, 8, and 9, and so forth. To avoid stigmatizing lower ability students, use various names for the tables, other than numbers or letters. Also, don't automatically put the top students at the first table you assign and the lowest ability students at the last table you assign.

Students at each table compete in simple math quizzes that cover content material that you have presented in class and on the study worksheets. You might, for example, quiz on math facts or problems and allow students to answer "Jeopardy" style, with the first right answer at a table earning a point, and an incorrect answer losing a point. Students compete as members of their teams, and the scores they earn at their tournament tables are added to make a total team score. Because students are assigned to ability-homogeneous competitive groups (the tournament tables), each student has an equal chance of contributing a maximum score to his or her team.

Following the competition, recognize successful teams and first place scorers at each tournament table. For future tournaments, members can remain on the same teams; however, you may have to change assignments to tournament tables to maintain equality of performance among each group of three students.

Variations

Student Teams—Achievement Divisions. In this variation, the same 4–5 member heterogeneous teams are used for studying math materials. Instead of competing in groups of three however, have all students take a written 15-minute quiz. Compare scores of students within six student "achievement divisions," i.e., the top six students on past math performance would be in Division Yellow, the next six students would be in Division Green, etc. Using this method, you will be comparing students within fairly homogeneous ability groups. Have the class decide ahead of time how to assign points for division winners and runners-up. These scores contribute to an overall score for each original team. For example, the top scoring student in each achievement division might earn ten points, the second student, eight points, and so forth. For subsequent quizzes, change division assignments to maintain equality in the divisions, but leave students in their original teams. Again, recognize winning teams and individual winners and runners-up in each division.

Jigsaw. In this variation, a student from each team focuses on learning and/or reviewing one particular skill or aspect of a problem solution. Members from different teams who are assigned to a particular topic or aspect study it together; then, each student teaches the material to their original teammates. All students take a quiz, and their scores are used individually or as contributions to team scores.

Small Group Teaching. In small group teaching, learning takes place through cooperative group inquiry, discussion, and data gathering by students. Students select subtopics within a general area selected by you—for example, salaries in different professions or occupations. Students organize into small groups of 2–6 members and subdivide the topic into individual tasks to be performed by group members. Each group then presents its findings to the class as a whole.

Activity

Cooperative Geometry

Objective To learn to solve problems cooperatively

Grade Level Grades 6–9

Math Concepts/Skills Geometry

Time 20 minutes or longer

Materials Hexagon pattern pieces on the following pages

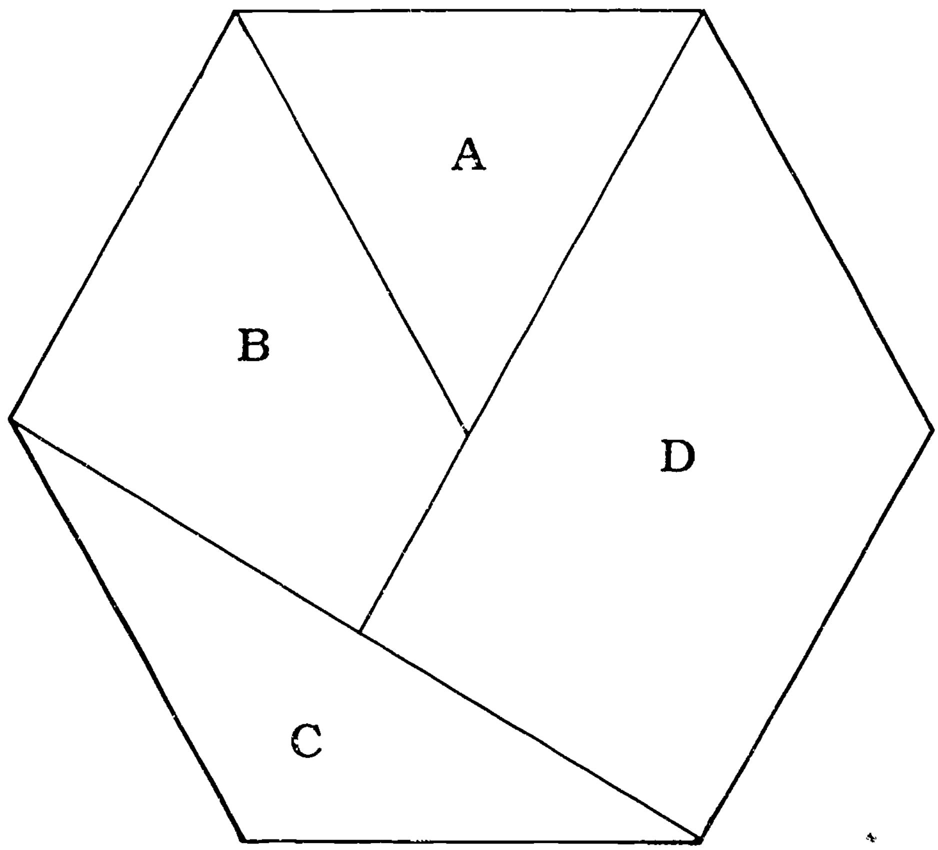
Procedure For each group, get six paper clips and one envelope. Duplicate the sheets on the following pages. Cut out the pattern pieces. Cut each piece along the solid lines. Clip together all the pieces marked A, all those marked B, and so forth. Put the clipped-together bundles into an envelope. Also, cut out and give each student a copy of the outline pattern.

Divide the class into groups of six arranged at tables or at desks pushed together.

Rules: Explain these to the groups before you start.

- No talking!
- Each member of the group gets one clipped-together bundle of shapes.
- Each member of the group is trying to build a complete hexagon.
- No one may take a shape from anyone else; the person with the shape must offer it to the person who needs it.
- The group is done only when all six members have completed their hexagons.

Variation Let students create their own puzzles.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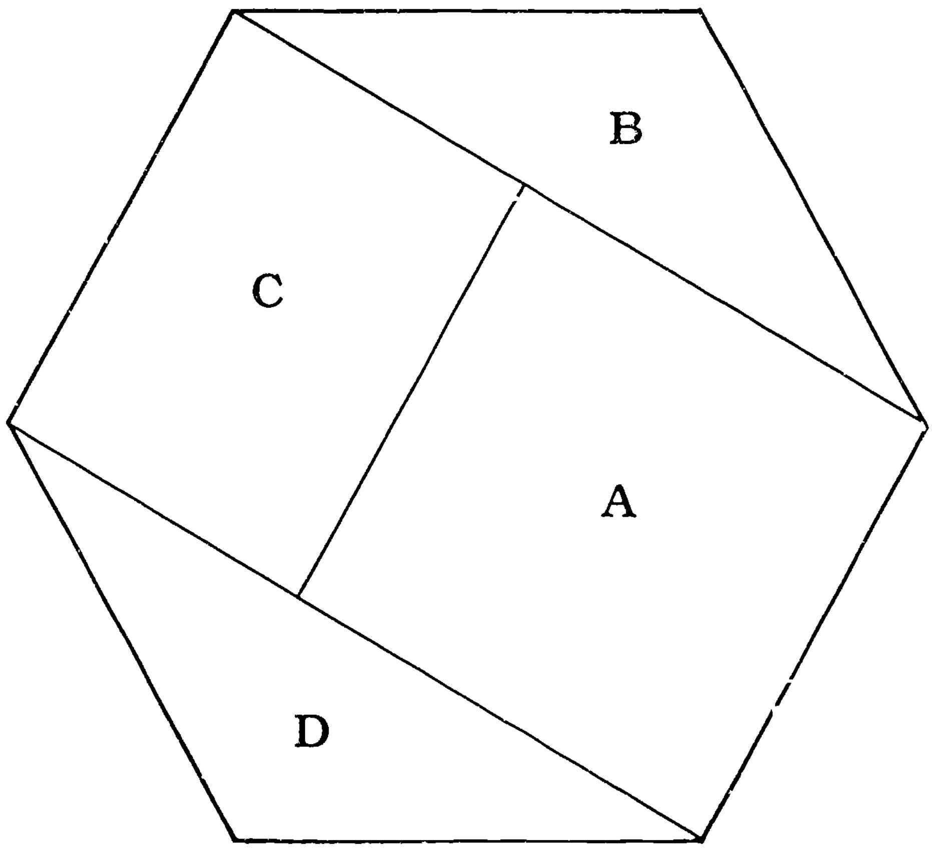
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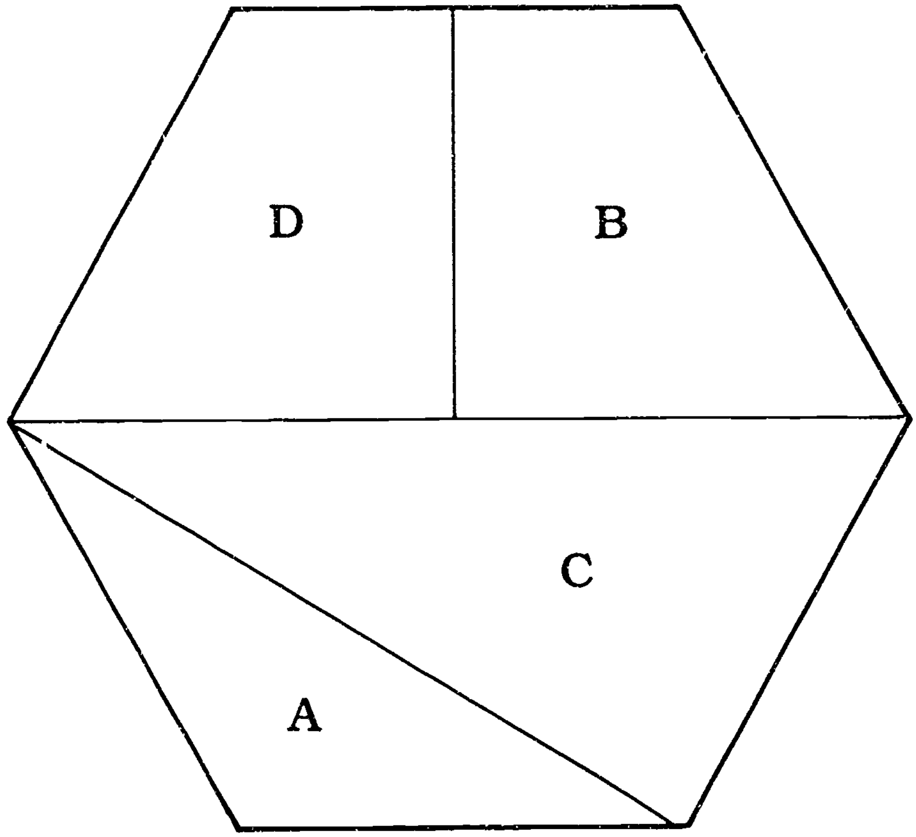
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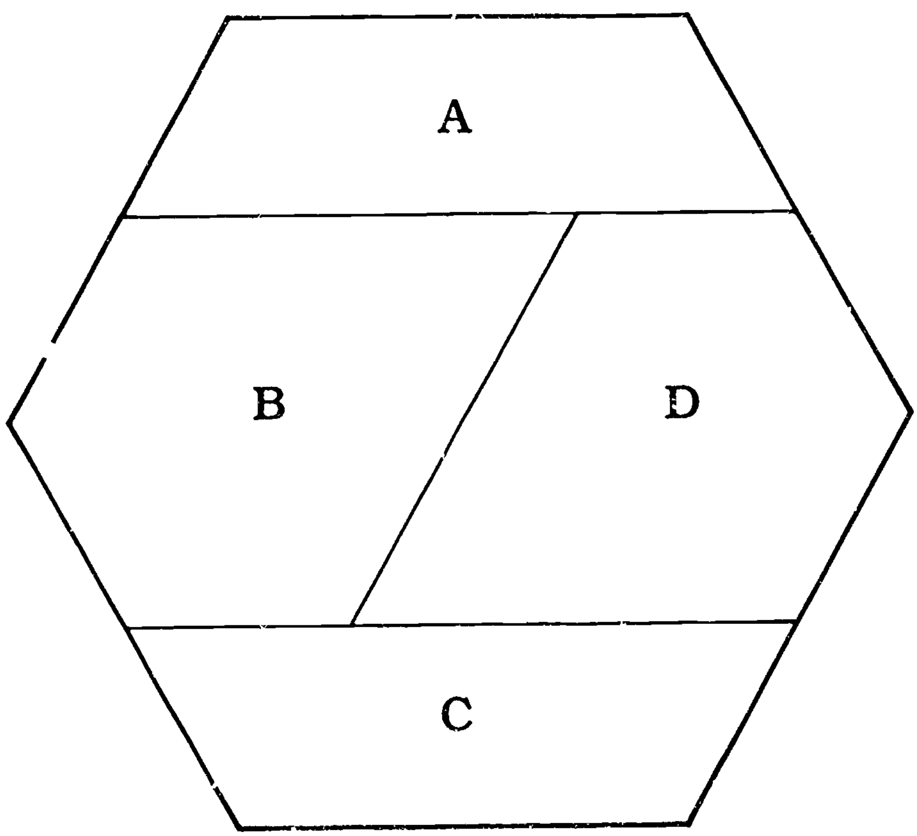
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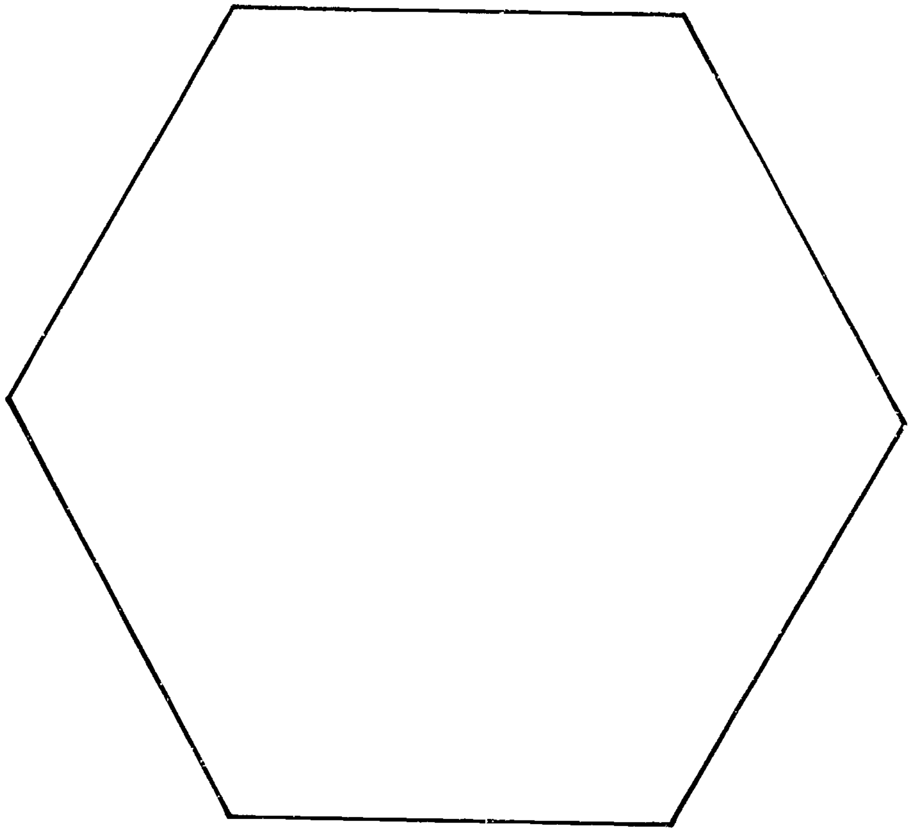
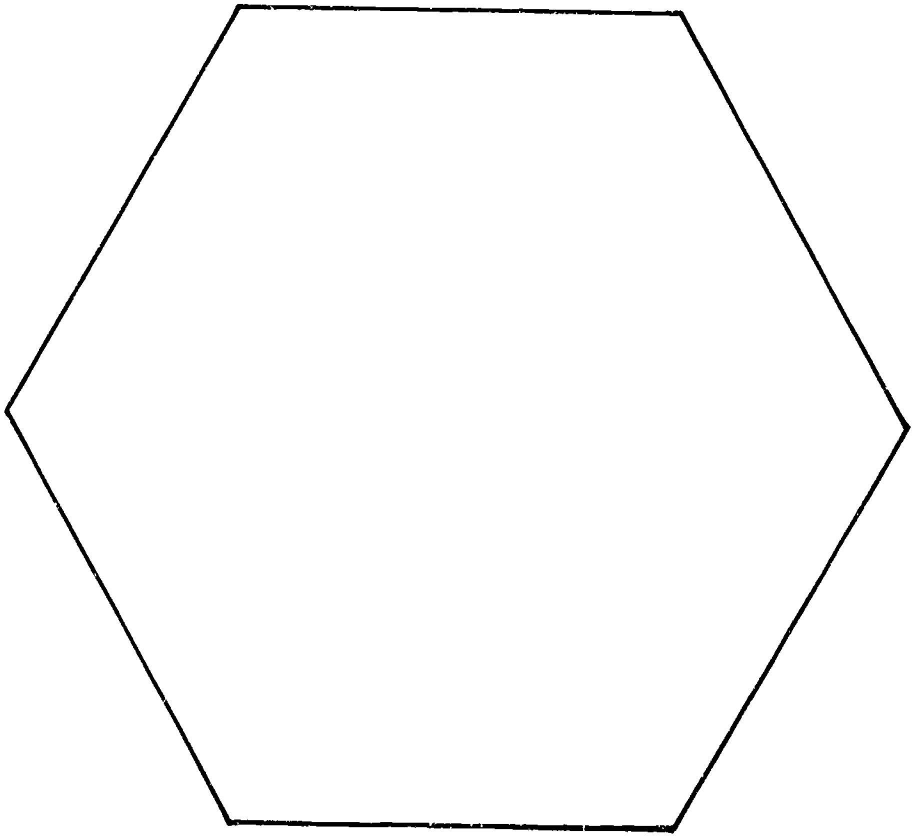




Activity

Cooperative Logic

Objective To allow students to learn to solve problems cooperatively

Grade Level Grades 6–9

Math Concepts/Skills Problem solving

Time 30 minutes

Materials Sets of clue cards on the following pages, envelopes

Procedure Duplicate the appropriate sheets, one for each problem. Cut out the six cards on each sheet, and place them in an envelope. Label the envelope with the name of the problem. Divide the class into heterogenous groups of four to six arranged at tables or desks pushed together. If there are going to be fewer than six people in the group, let groups distribute "leftover" cards to the players so that some of them have two.

After you've explained the rules, pass out one envelope to each group.

Rules: Explain these to the groups before you start.

- Distribute the clues among members of the group, one clue to each person.
- Each person may read her or his clue aloud, but may not show it to another player.
- Read the card with the number 1 on it first.
- The group is trying to solve a logic problem together.
- The group is done only when everyone agrees the problem is solved.

If this activity is too difficult for students, have them construct some "hands-on" props to help them solve each problem; for example, for problem 3, a circle representing the table and the four names.

Answers:

1. Barbara, Michael, Peggy, Diane, Robert
2. President—Jenny, executive secretary—Tom, salesperson—Jim, computer programmer—Heather

3. Carol—cheese and Coke, Gary—pepperoni and milk, Paul—mushroom and grape juice, Marie—green pepper and Pepsi

4. Architect—Judy, engineer—Sandra, accountant—Bill, chemist—JoAnne

5. 1925

Variation

Have students find or write additional simple logic problems and prepare clue cards for them. *Off and running* or *Get it together* by Erickson contains several good problems.

Handout

Clue Cards

1 **Peggy will be 12 years old tomorrow.** Put the students in order from oldest to youngest.	**Michael is 3 years older than Diane.** Put the students in order from oldest to youngest.
Diane is 9 years old. Put the students in order from oldest to youngest.	**Robert is 6 years younger than Peggy.** Put the students in order from oldest to youngest.
Barbara is 1 year older than Michael. Put the students in order from oldest to youngest.	**Peggy is the only one who has a birthday this month.** Put the students in order from oldest to youngest.

Handout

Clue Cards - Problem 2

1 Jenny, Heather, Tom, and Jim all work at a large company. One is a salesperson, one is an executive secretary, one is a computer programmer, and one is president. Which person holds each job?	The president works very closely with Tom. Which person holds each job?
Jim's salary is paid on a commission basis. Which person holds each job?	The salesperson and the president are the opposite sex. Which person holds each job?
Heather uses more math than anyone else in her job. Which person holds each job?	The computer programmer and president are the same sex. Which person holds each job?

Handout

Clue Cards - Problem 3

1 Carol, Gary, Paul, and Marie went out for a pizza. Only one person ordered a pizza and a drink that started with the first letter of their name. What did each person order?	They each ordered a different kind of pizza: mushroom, pepperoni, cheese, and green pepper. Gary didn't have vegetables on his pizza. What did each person order?
The person who drank milk also had a pepperoni pizza. What did each person order?	The person who ordered a mushroom pizza also had grape juice. What did each person order?
The person who ordered a cheese pizza also had a Coke. What did each person order?	The person who ordered a vegetable pizza drank Pepsi. What did each person order?

Handout

Clue Cards - Problem 4

1 Four people—Judy, JoAnne, Bill, and Sandra sat around a table at a business meeting. The architect sat next to the engineer. What is each person's occupation?	JoAnne sat on the architect's right. What is each person's occupation?
The chemist and Sandra sat across from each other. What is each person's occupation?	The accountant and the engineer sat next to each other. What is each person's occupation?
Bill and Judy sat across from each other. What is each person's occupation?	Bill was seated between the chemist and the engineer. What is each person's occupation?

Handout

Clue Cards - Problem 5

1

I'm thinking of one of these numbers:

845	**872**	**3625**	**2860**
2582	**2580**	**1925**	**1485**
1445	**1075**	**638**	**1376**
2315	**1690**	**1671**	**3815**
2780			

Which number is it?

The sum of the digits of this number is 17.

Which number is it?

The number has more than 3 digits.

Which number is it?

The number is a multiple of 5.

Which number is it?

The number is odd.

Which number is it?

The number is < 2573.

Which number is it?

Activity

Fund Raising for a Math Field Trip--The Cookie Store

Objective

To allow students to work cooperatively in teams to demonstrate their ability to plan and carry out a fund-raising activity (The activity could help finance a party, trip, or other special occasion.)

Grade Level

Grades 7–9

Math Concepts/Skills

Working with fractions, whole numbers, measurement, and estimation

Time

1–2 class periods (Most of the activity may be completed outside of class.)

Materials

Cookie ingredients and food preparation equipment, expense sheets (You may want to work cooperatively with a home economics teacher to carry out this activity.)

Procedure

Divide students into the following *mixed-sex groups:* planners, bakers, sellers, and accountants. The planners will be responsible for deciding what kinds of cookies to make and for figuring the amounts of ingredients to be purchased. The bakers will be responsible for preparing the cookies, including reducing or increasing recipes. The accountants will figure the amounts to charge for the cookies and the "net profit or loss," and the sellers will collect the money from the cookie sales and make change.

Variation

This activity could be carried out with any number of different types of fund-raising activities.

Resources

Cook, M. *Math materials*. Catalog. Balboa Island, California.

These materials include tiling sets, task cards, and books designed to add variety to math. The materials emphasize problem solving and focus on active student involvement. Also included are several books on cooperative leaning. A catalog is available from Marcy Cook, P.O. Box 5840, Balboa Island, CA 92662.

DeRoche, E. F., and Bogenschild, E. G. 1977. *400 group games and activities for teaching math*. West Nyack, NY: Parker.

This book includes 400 classroom-tested math strategies and activities suitable for use in cooperative mathematics learning for elementary and junior high students. The activities are enjoyable and focus on the practical implications of learning math in a cooperative classroom atmosphere.

Erickson, T. 1989. *Get it together*. Berkeley: University of California, Lawrence Hall of Science.

This activity guide presents a collection of over 100 "six bit" logic problems designed to facilitate cooperative learning. The problems cover a wide range of subject matter and difficulty. Suitable for grades 4–12.

Erickson, T. 1986. *Off and running: The computer off-line activities book.* Berkeley: University of California, Lawrence Hall of Science.

Off and running was developed to encourage minority and female interest in computers, math-based fields of study, and math-related careers. The content of the book includes on-line and off-line activities that teach computer concepts and skills. Activity themes focus on learning programming skills, cooperative learning, and equity in computer usage. This book has coupled excellent educational materials with strategies to promote equity. Content is suitable for grades 5–12.

Kaser, J. S. 1985. *Count me in! Guidelines for enhancing participation in mixed gender work groups*. Washington, DC: The Mid-Atlantic Center for Sex Equity.

This booklet includes guidelines for enhancing participation in mixed gender work groups. The suggestions can be very helpful for educators, since much of the school day involves group interaction.

Slavin, R. E. 1980. "Cooperative learning." *Review of Educational Research* 50, no. 2: 315–42.

This journal article summarizes the various methods of cooperative learning and the benefits for students who experience cooperative learning. A good basic reference on strengthening cooperative learning activities.

Stenmark, J. K.; Thompson, V.; and Cossey, R. 1986. *Family math*. Berkeley: University of California, Lawrence Hall of Science.

If mathematics promotion is a goal of your teaching. *Family math* activities will help you introduce parents and children to ideas that improve their math skills and help them gain an appreciation for math. Topics are geared to the K–8 math curriculum. Hands-on mathematical experiences provide families an opportunity to develop problem-solving skills by looking for patterns, drawing pictures, working backwards, working cooperatively with a partner, and eliminating possibilities. The

mathematical concepts learned in *Family math* are spatial relationships (geometry), estimation, data interpretation (probability and statistics), and mathematical reasoning.

Wiebe, A., and Hillen, J., eds. 1986. *AIMS Newsletter*. Fresno, CA: AIMS Education Foundation.

This newsletter describes the AIMS (Activities That Integrate Math and Science) Program. The program includes a wide range of science and math activities and focuses on the integration of learning experiences, problem-solving activities, and cooperative learning for grades K–9.

Implementing an Effort-Persistence-Mastery Approach to Problem Solving

The goal of this approach is for students to become interested in learning for it's own sake, that they will strive to understand and improve their own performance rather than judge themselves against other students—in other words, for students to become intrinsically motivated. For a variety of reasons, including the ways teachers assist them, girls are more likely than boys to exhibit "learned helplessness"; i.e., the feeling that one is incapable of learning without assistance. As discussed in the section on "Attribution Patterns," girls typically attribute failure to lack of ability, which often results in lack of persistence and lack of motivation to master mathematical concepts.

- Teachers typically encourage boys to figure out the answers to a problem; they are more likely to help girls by giving them the answers. (Sadker and Sadker 1985)
- Math teachers have been found to give different feedback to boys and girls for wrong answers—telling boys to try harder, while praising girls for "just trying"; this finding is consistent with the "learned helplessness" syndrome. (Fox 1981)
- Teachers contribute to "learned helplessness" in girls by praising them for intellectually irrelevant aspects of their responses, even when the responses themselves are incorrect (Russo 1985). Some examples: teachers often praise girls for the neatness of their work, even though it may be of poor academic quality; teachers often say to girls who failed, "That's okay, as long as you tried."
- In one study, it was found that girls were seldom criticized for the neatness and form of their work; about 90 percent of teacher criticism directed at girls focused on intellectual inadequacy of their work. Only about 50 percent of criticism directed at boys focused on intellectual inadequacy. (Dweck, cited in Grayson and Martin 1988)
- In another study, boys were found to be more likely than girls to persist in difficult tasks in which they had failed. (Hughes et al. 1986)
- Several investigators have found that females are not as involved in problem solving activities as males. However, the belief that females are not as intrinsically motivated in mathematics as males has been refuted by results from many other studies. (Fox et al. 1980)

- Teachers' encouraging comments are very important, particularly for girls. Some researchers have theorized that boys appear to have an intrinsic mastery motivation, whereas girls' motivation is more related to extrinsic need for approval. (Story and Sullivan 1986)

- To promote a mastery goal orientation in their classrooms, teachers need to provide optimally challenging learning activities, use an active teaching approach that's responsive to students' learning needs and interests, establish learning situations that allow and support student autonomy, and emphasize the interim value of learning. (Meece et al. 1989)

- A strong emphasis on grades or other external incentives does not foster a mastery orientation toward learning. By fostering a competitive atmosphere in the classroom, this approach may have a particularly negative effect on girls, who generally perform better in less competitive learning situations. (Meece et al. 1989)

The suggestions on the following pages are designed to help you increase an effort-persistence-mastery approach to problem solving for all students, and especially for girls.

Strategies

1. In your mathematics instruction, include information for males and females about the importance and usefulness of math. Help students develop a desire to learn math for its own value, not because they "have to."

2. Deemphasize right and wrong answers. Give special attention to process, so students can identify their errors and focus on specific areas needing improvement to attain understanding. Students will be reassured of their ability to master mathematical concepts if this approach is used.

3. Provide opportunities to increase problem-solving skills. To expose students to problem solving, try the "two problem approach." Each day at the beginning of class, put two problems on the board for students to solve. Be sure to give students an opportunity to discuss their solutions and the merits of each approach in solving these problems. *Use EQUALS to promote the participation of women in mathematics* by Kaseberg et al. (see resource list) emphasizes problem solving, geometry, and probability—areas that females need to strengthen.

4. Use guessing activities to help students develop estimating skills. Be careful not to reinforce wild guesses, but utilize wrong answers as a way of learning. Probing questions can guide students to restructure their thought processes. Such interactions will increase response opportunities and enhance students' self-concept—an area in which girls more than boys need assistance.

5. Ask students to state their problem-solving strategies, not just the answers. Focus on the use of appropriate methods and strategies rather than the "one right answer." Give students credit for using appropriate strategies. Explain that there is often more than one method to find the solution to a problem.

6. Use recreational and intuitive forms of mathematics. A technique to involve the whole class and to challenge students of all abilities is the use of "head" or oral problems. Head problems take a small amount of time and can be used to introduce new concepts and strengthen previous ones (see the following activity for examples of head problems). If students' mathematical errors are due to lack of attention to detail, head problems should help remediate these types of errors. When possible, recreational mathematics should incorporate activities to strengthen spatial relationship skills for all students, especially females.

7. According to Grayson and Martin (1988), the average time allowed by teachers for students to respond in class is 2.6 seconds. In mathematics classes, less response time is typically given to girls than to boys. Research suggests that this may be due to lower teacher expectations for girls in mathematics classes. Make sure you give all students an equal opportunity to answer. Don't answer for them or let girls "off the hook" too easily.

8. Encourage all students to figure out the answers to problems; don't give them the answers or do their work for them. Let girls know that their understanding is very important; it's not okay if they "just try."

9. When some students don't seem to understand, search for *alternative* ways to explain. Make sure that if the class has to move on, those students who have not mastered the concepts aren't left in confusion. While they study the next topic, give them additional help and practice outside regular math classes until they catch up with the rest of the group.

10. Help students focus on what they've learned and understood, not just on grades. As much as possible, stress a concept approach to math.

11. Make sure that all students understand that math is *not* a subject in which "either you catch on immediately" or "you don't catch on at all." Let them know that some topics in math are difficult, and that it takes persistence and practice to master math concepts. Also let them know that even the top mathematicians in the world are working on problems they can't solve or understand yet. If you encountered *and overcame* difficulties in math, this is good information to pass along to your class.

12. Don't be so "kind" to girls that you let them get by without mastering basic mathematics. Often, girls are "good students," and teachers believe they are showing concern for them when they don't insist on concept mastery. Be really kind and concerned by being firm and insisting that no student get by without mastering all basic arithmetic skills. Students who have trouble with the basic concepts of mathematics will be at a tremendous disadvantage in future math classes.

13. Don't give in to girls' tears. Respond to the frustration, not to the tears. Try to help girls work through problems in a calm, supportive way, without displaying undue solicitude or embarrassment.

14. To foster a mastery orientation in students, use problem-solving activities that elicit their active participation. Let small groups of students create and solve problems that are important and meaningful to them.

Activity

Head Problems

Objective
To motivate students to concentrate and follow problem steps

Grade Level
Grades 6–9

Math Concepts/Skills
Using whole numbers, fractions, mixed numbers, plus any other areas you want to emphasize

Time
Each problem takes one or two minutes (This is a great activity for "spare minutes" before the bell rings, or use as a warm-up.)

Materials
Suggested "head problems" below; slates, if desired

Procedure
Instruct students that you will be giving them a problem and that they need to listen closely, follow along, pay attention to every part of it, and work it in their heads. Read each problem aloud slowly. Make sure students are following its steps and are not using paper and pencils. Students can answer the problem orally or write their answers (only) on slates.

Variation
You can make up many of these problems on the spur of the moment, or ask students to make up head problems. You can also use these types of problems to help students learn measurements, history facts, and so forth, while practicing computation. Emphasize fractions, decimals, ratios, percentages, or whatever your students are currently learning.

Any of these problems can be put on cards and kept for future use. The card version is sometimes known as Crazy Cards.

1. Take the number of sides on a pentagon; multiply by 2; add 4; subtract 7. What is the number? (Answer = 7)

2. Start with the number of inches in a foot; divide by the number of legs on a spider; multiply by the number of days in a week; subtract the number of dimes in a dollar. (Answer = .50)

3. Start with the number of minutes in an hour; divide by three; add the number of sides on a triangle; add the number of years in a century; subtract the number of weeks in a year. (Answer = 71)

4. Start with the number of pounds in a ton; divide by 200; multiply by the number of sides in a quadrilateral; add the number of pints in a quart; subtract the number of weeks in half a year. (Answer = 16)

The idea for "head problems" was suggested by Tom Lester, San Juan Unified School District, Sacramento, California.

5. Start with the number that is the product of four times four; subtract the number that comes right before 14; multiply by the number of feet in a yard; divide by the number of tires on a bicycle. (Answer = 4 1/2)

6. Think of the number of months in a year; divide that number by the number of quarters in a dollar; add 2; multiply by 5. (Answer = 25)

7. Think of the number of leaves on a "lucky" clover; add to that number the number of years it took you to be 12 years old; add the third prime number; divide by the number of days in a week. (Answer = 3)

8. Take the number of states in the United States; divide by 5; add the number of fingers on both hands; subtract 2. (Answer = 18)

9. Take the number that comes after 19; double it; divide by 8 and add 4. (Answer = 9)

10. Take the whole number that is greater than 7 and less than 9; add the digit that tells you how many hundreds there are in 1,582; subtract the number of things in a dozen. (Answer = 1)

11. Take the number that makes the equation __ x 5 = 20 true; add the number of cents in a dime; subtract the first odd number that comes after 6. (Answer = 7)

12. Take the number 20; add 300; add 7; add 4,000. What is the number? (Answer = 4,327)

13. Take the largest remainder you could get if you divide a number by 8; multiply by the number of 5s in 3 tens; add the number of sides on an octagon. (Answer = 50)

14. Assuming the same rate, if 6 cars go through McDonald's in 15 minutes take the number that go through in 1 hour; add the number that is half of 100; subtract 6 dozen. (Answer = 2)

15. Take the number of days in February (when it isn't Leap Year), multiply by 2/7; multiply by 5; subtract the number of inches in a foot; divide by the number of angles of a rectangle. (Answer = 7)

16. Take the number of sides on a pentagon; double it; subtract 1; give the square root of that number. (Answer = 3)

17. Take the number 81; divide by 9; add the number of sides on a pentagon; divide by the number of days in a week; find that number on the clock; give the number that is 90° counterclockwise from it. (Answer = 5)

18. Think of the number of days in April; divide by the smallest 2-digit whole number; multiply by the second even digit; find that number on the clock; give the number that is 90° clockwise from it. (Answer = 9)

19. Take the number of cents in a dime; add negative 4; multiply by 8; add 2; add the digits; multiply by 1/5; show the answer on your fingers. (Answer = 1)

20. Take the number of wheels on a tricycle; divide by the first prime number; add the number of lives a cat has. (Answer = 10 1/2)

Activity

Goal Setting and Watching Your Progress

Objective

To help students learn to set academic goals and to monitor their progress in math; to reinforce the idea that students have control over their learning

Grade Level

Grades 6–9

Math Concepts/Skills

Computing statistics and constructing line graphs

Time

5–10 minutes per day

Materials

"Math Progress" worksheet (shown on page 208), folders for each student, felt tip pens

Procedure

Learning to set and obtain goals may be one of the most important life skills you can teach to a child.

Provide a folder for each student. Staple a "Math Progress Sheet" into each folder, and have students fill in their name and the date. Ask students what grade they plan to obtain this grading period. Have them place that grade on the blank space entitled "First Grading Period Goal." Ask students to answer the question "What will I do to accomplish this goal?"

For the first half of the grading period, give students weekly grades, plus test or quiz grades. Have students draw a line graph of their grades with felt tip pens. Let them keep important papers and tests or quizzes in the folder.

At the midterm point, give students an update on their grade, or have students compute their own averages. Have students place that grade on the blank space entitled "Midterm Grade." Discuss with each student how she or he can obtain the goals she or he set, and praise students who are accomplishing realistic goals.

These folders can also be used at parent conferences. It is helpful for parents to see their children's work and goals. At the beginning of each grading period, start fresh with a new "Math Progress Sheet."

Variations

1. Before a test or quiz begins, ask students to place the grade they are trying for on the upper left hand corner of their papers. When the graded papers are returned, students will see how their goals and scores matched. If there is a large difference, have an individual conference with the student to see if you can help. Students will begin to realize that goal setting, studying, and paying attention in class will result in better grades.

2. Ask students to also write down the amount of time they studied next to their expected grade. Let each student compare their own grades with study time over the grading period.

3. Grades and test scores are just one (often imperfect) measure of learning. If you use an alternative method of assessing students' progress, let them set their goals based on that standard. For example, students could graph their progress toward mastering various mathematical concepts.

Worksheet

Math Progress Sheet

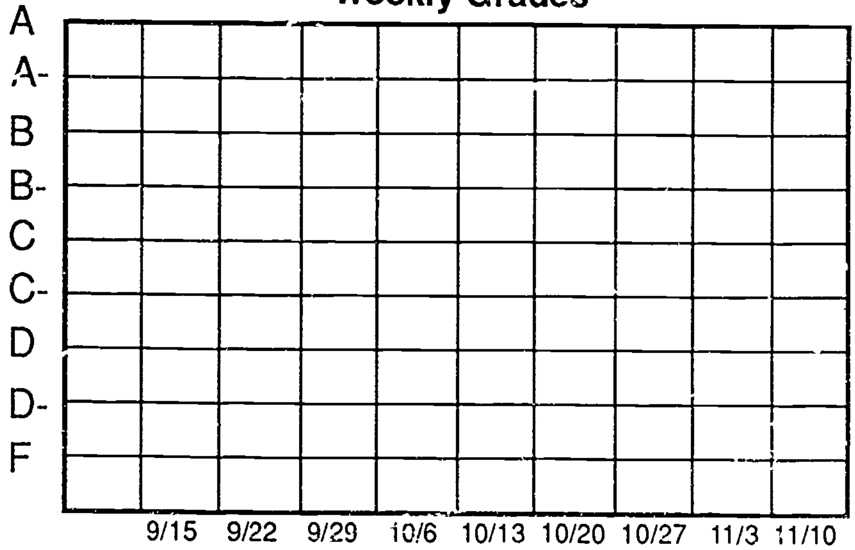
Name ______________________________ Date ____________________

First Grading Period Goal ________

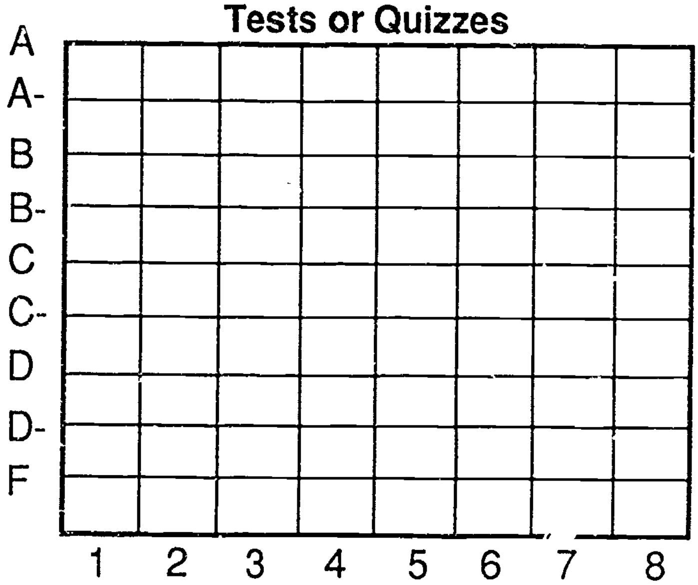
Midterm Grade ________

What will I do to accomplish this goal? ______________________________

Weekly Grades



Tests or Quizzes



Activity

Problem Problems and Strategies

Objective To give students practice using various strategies to solve challenging problems

Grade Level Grades 6–9

Math Concepts/Skills Problem solving

Time 5–15 minutes or longer (This would be a good "sponge" activity.)

Materials Problems on the following page or make up your own

Procedure Put the following problem-solving strategies on the board, discuss each with students, and let them practice each strategy until they feel comfortable using it.

Problem-Solving Strategies

1. Use a five-step plan:
   - Read the problem.
   - Plan what to do.
   - Do the arithmetic.
   - Give the answer.
   - Check the answer. (Is it reasonable? Does it make sense?)
2. Choose the arithmetic operation(s).
3. Use logical reasoning.
4. Draw a picture or diagram.
5. Guess and check.
6. Make a model.
7. Solve a simpler problem.
8. Make an organized list.

Strategies are from D. Thoburn, 1987. *Macmillan mathematics.* New York: Macmillan Publishing Company. (This text series includes detailed examples of each strategy.)

9. Make a table.

10. Find a pattern.

11. Work backward.

Use the problems below or problems from the resource books listed following this activity to challenge students. Ask them to provide their strategies as well as their answers. Other excellent sources of problems are classroom texts or other publisher's math text books. Check your local college or university library for these.

1. A bottle and a cork cost one dollar and a dime. The bottle cost one dollar more than the cork. How much did the cork cost? (Answer = $.05)

2. Sue bought a turtle for $5. She sold it to Ben for $7. Ben did not want to keep the turtle, so Sue bought the turtle from Ben for $8. By now the turtle was bigger so she sold it to Ann for $9. How much money did Sue make? (Answer = $3)

3. If there are four people in a room and everybody shakes hands once with each of the other people, how many hand shakes will there be? (Answer = 6)

4. Ms. McDonald had a farm with ducks and donkeys. There were 24 animals in all. Counting webbed feet and hoofed feet, if these animals had a total of 62 feet in all, how many ducks and how many donkeys does Ms. McDonald have? (Answer = 17 ducks and 7 donkeys)

5. Susan had 5 cages and 10 guinea pigs. She wanted to put her guinea pigs into the cages so that each cage contained a different number of animals. How could this be done?

   Answer: Cage 1: 0
   Cage 2: 1
   Cage 3: 2
   Cage 4: 3
   Cage 5: 4
   4 + 3 + 2 + 1 + 0 = 10

6. Janet had 9 coins that were worth $1.17, but she couldn't make change for a dollar. What coins did she have? (Answer = 3 quarters, 4 dimes, and 2 pennies)

7. A store has boxes of chocolate chip cookies in two sizes—large and small. If 4 large boxes and 1 small box weigh the same as 9 small boxes, how many small boxes would weigh the same as 1 large box? (Answer = 2)

8. On her bicycle trip, Anne started in Berne and rode through four other towns along State Road 1. Farmington was twice as far from Berne as Jacksonville was; Farmington was also the same distance from Jacksonville as it was from River Falls. Tyler City was only 3 miles beyond Farmington. Name the towns Anne rode through in order. (Answer = Berne, Jacksonville, Farmington, Tyler City, and River Falls)

9. John wants to cook an egg exactly 5 minutes. He has a 3-minute and a 4-minute timer. How can he be sure of cooking a 5-minute egg using these two timers? (Answer = Set both timers to start; when the 3-minute timer goes off, start cooking the egg; when the 4-minute timer goes off, reset it—1 minute + 4 minutes = 5 minutes)

10. There were 6 teams in a bowling league. Each team played each of the others twice. If there were no ties, how many total games were lost during league play? (Answer = 30)

11. A grocer has a balance scale with 3 weights; she can weigh any produce from 1 to 13 pounds. What are the sizes of the weights? (Answer = 1, 3, and 9 pounds—either adding or subtracting, these three numbers can be combined to produce each number from 1 to 13)

12. A jeweler was asked to appraise 8 diamonds that all looked exactly alike—seven were real and one was a fake. The fake weighted less than the others. Using a balance scale and no other weights, what is the smallest number of weighings needed to find the fake? (Answer = 2; divide gems into groups of 3, 3, and 2. Weigh the two groups of 3 against each other. If one group is heavier, weigh 2 of the them against each other; if they are the same, the fake is the third one. If the groups of 3 are the same, weigh the remaining 2 against each other.)

13. Joyce had 25 coins that totaled exactly $1, including at least 1 penny, 1 nickel, 1 dime, and 1 quarter. What were the 25 coins? (Answer = 1 quarter, 3 dimes, 6 nickels, 15 pennies)

Resources

Casserly, P. L. 1983. "Encouraging young women to persist and achieve in mathematics." *Children Today* 12, no. 1: 8–12.

Casserly's article summarizes the factors that enhance or inhibit young females in their study of mathematics. Many strategies for classrooms, counselors, and parents are discussed.

DeRoche, E. F., and Bogenschild, E. G. 1977. *400 group games and activities for teaching math.* West Nyack, NY: Parker.

This book includes 400 classroom-tested math strategies and activities suitable for use in cooperative mathematics learning for elementary and junior high students. The activities are enjoyable and focus on the practical implications of learning math in cooperative classroom atmosphere.

Holden, L. 1987. "Math: Even middle graders can learn with manipulatives." *Learning 87* 16, no. 3: 52–55.

Learning fractions can be frustrating; this article includes many ways that manipulatives can be used to help middle school students understand fractions and learn geometric concepts.

Kaseberg, A.: Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. The purpose of the program is ultimately to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes sections with activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction.

Overholt, J. L. 1978. *Dr. Jim's elementary math prescriptions.* Santa Monica, CA: Goodyear.

Dr. Jim's elementary math prescriptions is a resource for educators in grades K–8 who are searching for effective methods of teaching mathematics. Each mathematical concept is presented with alternative methods to accommodate students with varied learning styles, abilities, and interests. Selected activities provide enjoyable mastery practice, so that students will develop mathematical competence and appreciation.

Stenmark, J. K.; Thompson, V.; and Cossey, R. 1986. *Family math.* Berkeley: University of California, Lawrence Hall of Science.

If mathematics promotion is a goal of your teaching, *Family math* activities will help you introduce parents and children to ideas that improve their math skills and help them gain an appreciation for math. Topics are geared to the K–8 math curriculum. Hands-on mathematical experiences provide families an opportunity to develop problem-solving skills by looking for patterns, drawing pictures, working backwards, working cooperatively with a partner, and eliminating possibilities. The

mathematical concepts learned in *Family math* are spatial relationships (geometry), estimation, data interpretation (probability and statistics), and mathematical reasoning.

Encouraging Independent Thinking, Intellectual Risk Taking, and Creative Problem Solving

Creativity in mathematics has been defined as "the ability to produce original or unusual applicable methods of problem solution; . . . combine ideas, things, techniques and approaches in a new way; [or] . . . analyze a given problem in many ways, observe patterns, see likenesses and differences, and on the basis of what has worked in similar situations, decide on a method of attack in an unfamiliar situation" (Aiken 1973). Creativity sometimes requires that a person take the risk of standing out or of being different from others. Creativity in mathematics requires that students feel independent and confident enough about themselves and their abilities to stand up for their own ideas.

Girls in our culture have traditionally been more dependent than boys; many are reluctant to take intellectual risks, and they are very concerned about "looking stupid" or being embarrassed. Girls are also less likely to ask questions or to experiment with different methods to solve a problem. Since creativity is extremely important in advanced mathematics, it is necessary that we help girls experience their own creativity at an early age.

- Girls are less willing than boys to be wrong and less likely to experiment with different ways to solve a problem. (Kreinberg and Stenmark 1984)

- Independence training facilitates math achievement, and the early socialization of girls typically includes less independence training than that of boys. (Stage et al. 1985)

- Humiliation by a teacher was a primary reason given by a sample of high school girls who decided not to continue in math. (Sherman 1982)

- In the classroom, boys are more often encouraged to be creative and to persevere, whereas girls are rewarded for being docile and conforming. (Harway and Astin 1977)

- Girls' creativity is decreased in competitive situations. (Amabile, cited in Kohn 1986)

- Although teachers' practice of not being too hard on girls in mathematics may be well intentioned, it results in girls' not becoming independent problem solvers who do well in high-level cognitive tasks. (Fennema 1983)

- Teachers reported that they rewarded the creative activity of boys three times as often as that of girls. (Torrance, cited in Grayson and Martin 1988)

- In most traditional schools, boys become leaders in problem solving, whereas girls become followers. (Minuchin, cited in Fox et al. 1980)

- Children enter school with girls tending to be more dependent on others and boys tending to be more self-reliant; through classroom practices, schools reinforce and further develop these dependent/independent behaviors in each sex—particularly in mathematics. (Fennema 1983)

- Several authors have speculated that the greater attention, both positive and negative, that boys receive in the classroom makes them more exploratory, more autonomous, more independent, and more oriented toward achievement in mathematics. (Stockard et al. 1980)

The strategies and activities that follow are designed to help students experience creative problem solving and to help them learn to take risks without worrying about experiencing embarrassment or humiliation.

Strategies

1. To develop creativity in students, a teacher must provide opportunities for personal initiative and responsibility. Although girls seem to be more creative in group situations, they also need to learn to become independent.

2. Structure some activities in your math classes where guessing is encouraged, and there is no penalty for wrong answers. Make it "okay" and never embarrassing for girls to give a wrong answer. Use wrong answers to help the student think through the process and come up with the correct answer, without humiliation. In other words, build a "safe" environment in your class in which everyone can take intellectual risks without fear of embarrassment.

3. Some teachers model making a mistake; they have the class help them think it through, and then find the correct solution to a problem. This can have a positive effect on your female students by letting them know that everyone makes mistakes, and that we can often learn more from our errors than from our successes.

4. Stress alternative approaches to problem solving and understanding mathematical concepts. Researchers have found that girls often use verbal strategies to solve problems, when spatial strategies such as diagramming, organizing the information into charts, or working backwards would be more helpful. Teach different approaches and strategies for problem solving, and encourage girls to use them—especially visual/spatial strategies and manipulatives—when they are unable to solve a problem using traditional methods.

5. Some authors have explained girls' relatively stronger math achievement in the elementary grades and lower achievement in high school by the following: Girls are taught and encouraged to obey rather than challenge rules. This may prepare them very well for elementary math, but hinder them tremendously at advanced levels. Be sure you encourage both girls and boys to examine and challenge the "rules" of math; through this process comes understanding rather than dependence on rules.

6. The same types of guessing, checking, and estimating activities that are discussed in the section on building math confidence can also be used to increase students' intellectual risk-taking behaviors. Many teachers have noted that girls seem afraid to guess and that they dislike estimating activities. Present these as "fun" activities, and be sure to specifically involve girls in these procedures.

7. Some teachers have speculated that because of societal pressures, girls are expected to be well-behaved "perfect ladies," while boys are expected to "have more fun." This pressure can lead to girls' fear of taking risks and making mistakes. Try to ensure that girls enjoy math activities.

8. Use "brainstorming" to encourage intellectual risk taking. Encourage students to develop problems for the class to solve and to present their solutions for the class.

9. Insist that girls become independent, self-reliant problem solvers. Be sure to reward their creative efforts and intellectual risk-taking behaviors.

10. The books *How to encourage girls in math and science* by Skolnick et al., *Math for smarty pants* by Burns, *Math for girls and other problem solvers* by Downie et al., and *Use EQUALS to promote the participation of women in mathematics* by Kaseberg et al. contain excellent examples of problems you can use to supplement texts. Further information on these books can be found in the resource list following this section.

11. The ability to "break set," or see beyond the expected is one element of independent thinking and creativity in mathematics. The book *Math for girls and other problem solvers* (see above) contains a number of activities that help children learn to break set. These include a series of "mystery stories" in which students have to look beyond the obvious to solve a problem and toothpick puzzles, which involve breaking visual set to find new patterns.

12. Many of the books mentioned above also contain good examples of logic problems. These give students practice using deductive reasoning to solve problems. *Family math* by Stenmark et al. (see resource list) contains an excellent game called Rainbow Logic, which also teaches reasoning in a very interesting way.

13. Look at the "Mindwinders" columns in *Instructor* magazine for interesting logic problems for your students.

Activity

Strategy Games—Card Tricks and Mind Reader

Objective To allow students to discover and practice problem-solving strategies

Grade Level Grades 6–9

Math Concepts/Skills Problem solving using simple logic

Time 10–20 minutes

Materials A deck of playing cards with the jokers removed, scratch paper, and pencils

Procedure

Card Tricks—Demonstrate this trick first, then play the game over, and let students guess the card. To play the game, you turn your back, let a student select a card from the entire deck, show it to the class, and place it face down on her or his desk. Explain to students that in this game, the ace is the lowest card and that the order of the cards above the 10 is jack, queen, king. Also define the suits. The object of the game is for the person doing the "card trick" to identify the correct card in as few guesses as possible. The person doing the "trick" asks the following types of yes or no questions: "Is it a red card?", "Is it a spade?", "Is it higher than 5?", "Is it lower than 3?", "Is it the 10?", and so forth. (Note that if the card was the 5 and the question was "Is it higher than a 5," the answer would be "no." If the card in question was the 3 and the question was "Is it lower than 3," the answer would be "no.") After you have successfully guessed the card and demonstrated the trick, you can select a new card, place it face down, and let students try to guess it with as few questions as possible.

Allow students to use paper and pencils to keep track of their guesses. For each game, designate one student as monitor, and let that student count and write the guesses on the board. Seeing how questioning has progressed should help students develop successful strategies. This game also teaches the value of wrong guesses—for example, when students ask, "Is it a red card?", and the answer is "no," they have now narrowed it down to a black card. In this game a "no" answer can sometimes be more valuable than a "yes." After they have played the game a few times, help students focus on developing a strategy to narrow down their choices and rule out incorrect answers.

Mind Reader—This game is similar to Card Tricks. One person thinks of a two- or three-digit number and writes it down. The person thinking of the number tells the group (the "mind readers") the number of digits. Students may ask questions similar to those in Card Tricks; i.e., "Is it higher than 5?", "Is it lower than 300?", "Is it odd?", "Does it begin with 7?" Again, the object is to "read the person's mind" and guess the number in as few tries as possible.

Variation

Another way to play this game is to have one person think of a number and give three to five clues. For example, "I'm thinking of a three-digit number; its digits are all even and all different; the sum of the digits is 18; the hundreds digit is twice as large as the tens digit. What is the number?" (Answer = 846)

The book *Use EQUALS to promote the participation of women in mathematics* by Kaseberg et al. (see resource list) contains several strategy games, including Bagels, another interesting guessing game that involves strategy development and may be played on several levels of complexity.

Activity

Magic Triangles

Objective To allow students to experiment with mathematical strategies to discover patterns

Grade Level Grades 6–9

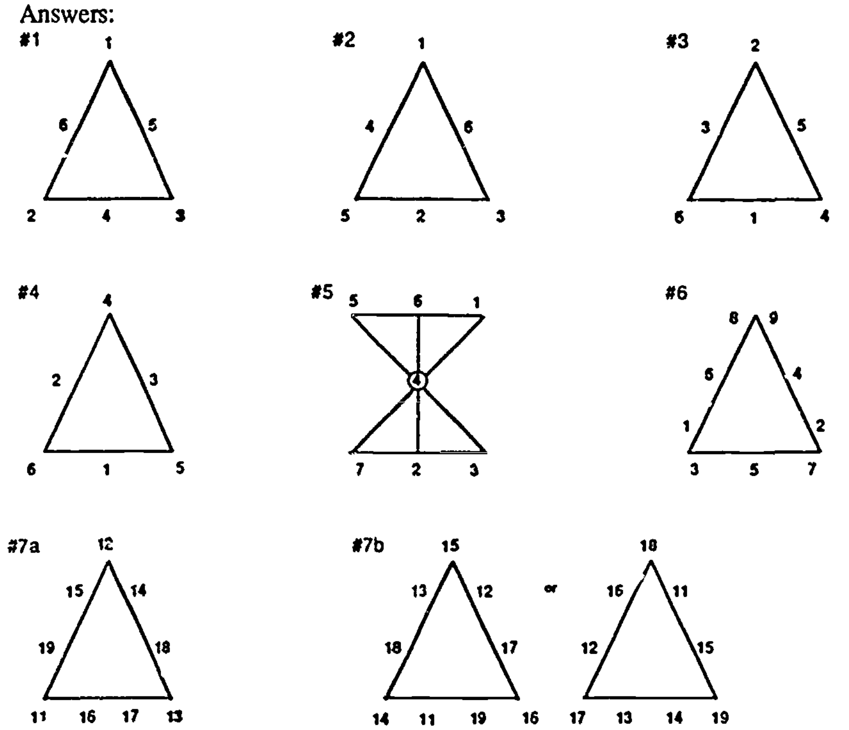
Math Concepts/Skills Problem solving

Time 5–10 minutes per puzzle (can also be used as a "sponge" activity)

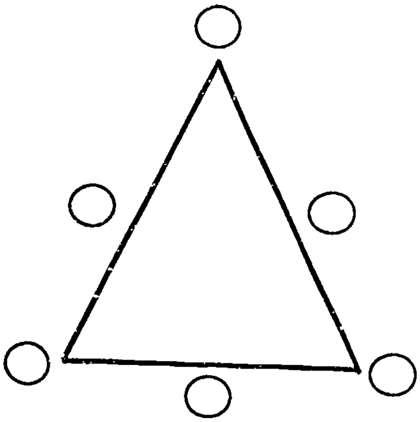
Materials Copies of the figures on the following pages (For younger students, you may also want to provide numbered circles, clips, or tiles that can be easily manipulated during trial-and-error solution.)

Procedure Give each student a copy of the puzzles. Have students follow the instructions on each puzzle. They can work individually or in groups. After each puzzle is completed, ask students to share the process they used to find their answers. Also, ask them to look for patterns when solving questions 1–4 and 7a and b.

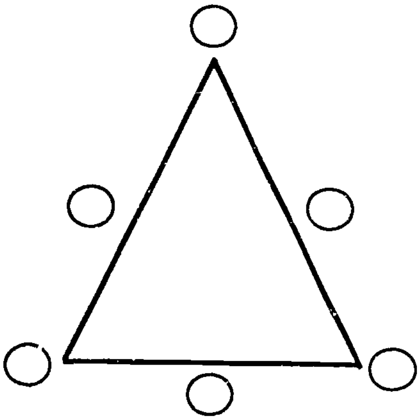
Answers:



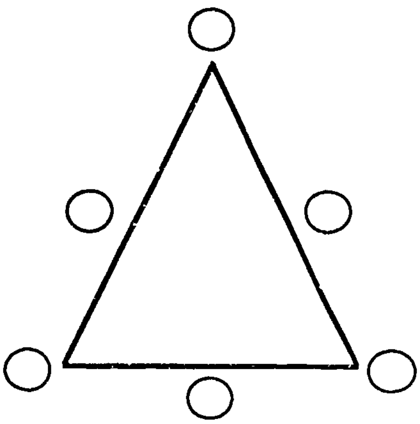
Possible strategies for puzzle 6 include trial and error with the 9 numbers, or add the numbers and divide by 3. That tells us that each side must equal 15. Now use trial and error to find sets of numbers that will add up to 15.



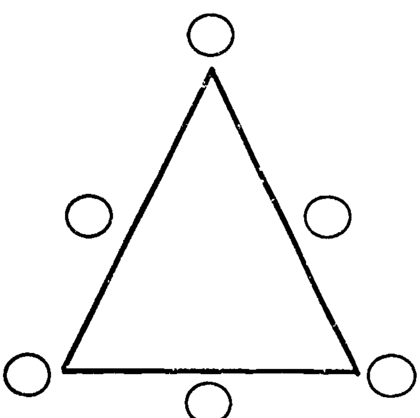
Puzzle 1: Arrange the numbers 1–6 in the circles so that each side adds up to 9.



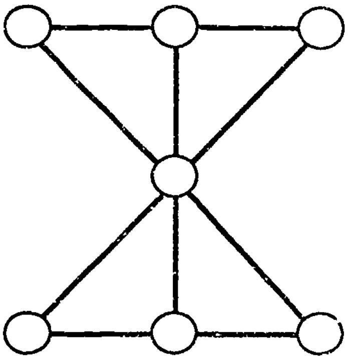
Puzzle 2: Arrange the numbers 1–6 in the circles so that each side adds up to 10.



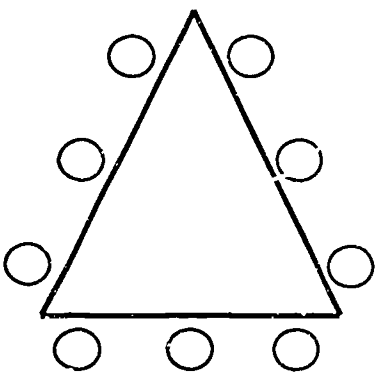
Puzzle 3: Arrange the numbers 1–6 in the circles so that each side adds up to 11.



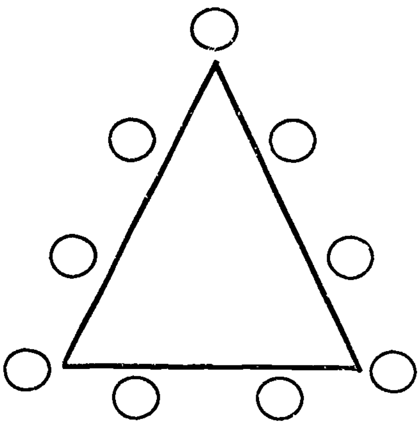
Puzzle 4: Arrange the numbers 1–6 in the circles so that each side adds up to 12.



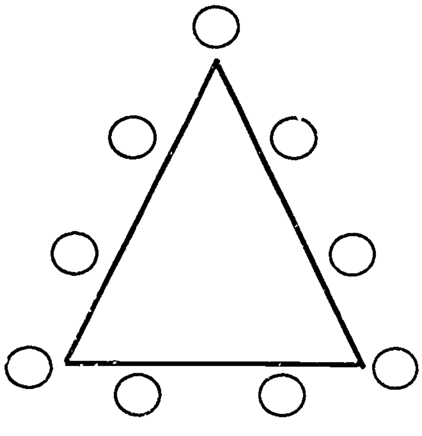
Puzzle 5: Arrange the numbers 1–7 in the circles so that each row, the vertical column and the two diagonals, adds up to 12.



Puzzle 6: Arrange the numbers 1–9 in the circles so that each side has the same total. Use each number only once.



Puzzle 7: (a) Arrange the numbers 11–19 in the circles so that each side totals 57. (b) Rearrange the same numbers so that all three sides are equal and total a number greater than 57. (c) How many different solutions are there, using these numbers?



Activity

More Problems

Objective

To practice problem solving and learn the "time" value of money (Problems A and B); to practice finding different solutions and using different problem-solving strategies

Grade Level

Grades 6–9

Math Concepts/Skills

Problem solving

Time

5–10 minutes per problem

Materials

"More Problems" handout on following page, calculators

Procedure

For problems A and B, let students read the problem. Before they attempt a solution, let students estimate and vote on their answers. Then allow 5–10 minutes for solution with calculators.

For problem C, working in pairs, have students read the word problem and find two different methods to solve it.

For problem D, let students work this problem individually or in pairs, noting their strategy.

Answers:

Problem A

At one cent doubling every hour, Susan would earn $328 in two days.

Problem B

$25 x 52 = $1,300 in the bank per year. At 8% interest, after 12 years they would have accumulated $23,371.

Problem C

Solution 1: Fill the 5-quart can, then pour from it to fill the 3-quart can. You will have two quarts left in the 5-quart can; pour that into the mower. Repeat the process, filling the 5-quart, transferring to the 3-quart, and putting the remaining two quarts in the mower. 2 quarts + 2 quarts = 1 gallon.

Solution 2: Fill the 3-quart can; pour it into the 5-quart can; fill the 3-quart can again, and use that gasoline to fill the 5-quart can. It will take two more quarts with one left over. Pour the remaining quart into the mower. Then transfer the gas from the 5-quart can back to the 3-quart can. Pour the full 3-quart can into the mower. 1 quart + 3 quarts = 1 gallon.

Problem D

40 minutes, because 8 cuts are needed.

Variation

Using their calculators, students can develop and find solutions for many problems that involve compounding; i.e., problems about savings and interest. For example, if you put $10,000 in a savings account that earns 8% interest per year, and you left all the money in the account, how long would it take before your money had doubled (to $20,000)?

Handout

More Problems

Problem A

Susan was offered a job that would last only two days. Her boss said she could choose either to earn $100 a day or to start at one penny per hour, and then her salary would double every hour. If Susan were going to work two days for eight hours per day, which would be the best deal—$100 per day or starting at one cent per hour with her wage doubling every hour? Which would you choose?

Problem B

When Janet started first grade her parents started saving for her college education. They could only save $25 per week, and they put this money in the bank once a year on December 31. It earned 8% interest. When they started saving, Janet's father said, "We'll never save enough to send her to a good college." About how much money had they saved by the time Janet finished high school.

Problem C

Monica and Pat made money by mowing lawns during the summer. The mower used a mixture of gasoline and oil. They had two gas cans—one held three quarts and the other held five quarts. The cans were not marked in any way. The lawn mower required exactly one gallon of gasoline to be mixed with one quart of oil. Using the 3-quart and 5-quart containers, how did the girls measure exactly one gallon of gasoline? Write two different solutions.

Problem D

If it takes five minutes to cut through a 9-foot pipe, how long will it take to cut the pipe into nine equal pieces?

Activity

Creative Numbers

Objective

To help students become aware of the many ways numbers are used in everyday life

Grade Level

Grades 6–9

Time

20–60 minutes plus (can be used as a take-home activity)

Materials

"Easy Creative Numbers" and "Harder Creative Numbers" worksheets on the following pages

Procedure

Divide students into small groups of three to four persons. Ask students, individually or in groups, to use their imaginations to determine what the letters on the worksheets stand for. Start with the easy ones, then let students tackle the advanced sheet. Ask students to make their own creative number statements or ask their parents for help. Note that students may come up with some answers that are different from the ones shown below. If the answer fits, it's correct. You may also make overhead transparencies of worksheets and complete them as a project for the entire class.

Answers to easy numbers:

1. days of the week
2. months of the year
3. legs on a centipede
4. quarters in a dollar
5. cents in a dime
6. legs on a millipede
7. legs on a spider
8. things in a dozen
9. states in America
10. sides on a triangle
11. letters in the alphabet
12. planets in the solar system

Answers to harder numbers:

1. days in a year
2. inches in a foot
3. sides on a square
4. holes on a golf course
5. feet in a yard
6. minutes in an hour
7. cards in the deck (with the jokers)
8. angles in a triangle
9. degrees in a right angle
10. centimeters in a meter
11. wonders of the world
12. quarts in a gallon

13. stripes on the American flag
14. hours in a day
15. eyes on a face
16. legs on a human being
17. pins on a bowling lane
18. blind mice

13. months in a year
14. signs of the zodiac
15. wheel on a unicycle
16. seconds in a minute
17. keys on a piano
18. degrees Fahrenheit at which water freezes
19. dollars for passing go in Monoply
20. digits in a zip code
21. sides on a stop sign
22. players on a football team

Worksheet

Easy Creative Numbers

Directions: We use numbers in many ways. Each statement below contains numbers and the initials of words that will make it correct. Fill in the correct words.

Example: 2 A on a B Answer: 2 arms on a body

1. 7 D of the W ______________________________
2. 12 M of the Y ______________________________
3. 100 L on a C ______________________________
4. 4 Q in a D ______________________________
5. 10 C in a D ______________________________
6. 1000 L on a M ______________________________
7. 8 L on a S ______________________________
8. 12 T in a D ______________________________
9. 50 S in A ______________________________
10. 3 S o.. a T ______________________________
11. 26 L in the A ______________________________
12. 9 P in the S S ______________________________
13. 13 S on the A F ______________________________
14. 24 H in a D ______________________________
15. 2 E on a F ______________________________
16. 2 L on a H B ______________________________
17. 10 P on a B L ______________________________
18. 3 B M ______________________________

Worksheet

Harder Creative Numbers

Instructions: Each statement below contains numbers and the initials of words that will make it correct. Fill in the correct words.

Example: 16 O in a P Answer: 16 ounces in a pound

1. 365 D in a Y ______
2. 12 I in a F ______
3. 4 S on a S ______
4. 18 H on a G C ______
5. 3 F in a Y ______
6. 60 M in an H ______
7. 54 C in the D (with the Js) ______
8. 3 A in a T ______
9. 90 D in a R A ______
10. 100 C in a M ______
11. 7 W of the W ______
12. 4 Q in a G ______
13. 12 M in a Y ______
14. 12 S of the Z ______
15. 1 W on a U ______
16. 60 S in a M ______
17. 88 K on a P ______
18. 32 D F at which W F ______
19. 200 D for P G in M ______

20. 5 D in a Z C ______________________________

21. 8 S on a S S ______________________________

22. 11 P on a F T ______________________________

Activity

Find the Missing Numbers

Objective To allow students to practice adding and multiplying in a problem-solving format

Grade Level Grades 6–9

Math Concepts/Skills Problem solving, using decimals

Time 30–45 minutes

Materials "Find the Missing Numbers" worksheets A, B, and C on the following pages

Procedure Duplicate one copy of each worksheet for each student. Ask students to complete the squares using the hints provided. Answers are on the following page. Note that problems on worksheet B have at least two solutions. Suggest a trial-and-error approach to finding a set of missing numbers. To help students with some of the more difficult problems, you could supply one or more numbers for each square.

Answers to A:

Row 1	1	3	6	3	1	2	5	1	5
	4	2	7	4	3	5	2	6	3
	2	5	2	7	6	3	5	4	7
Row 2	1	6	7	2	1	9	1	7	2
	5	3	4	4	5	7	4	5	3
	9	2	5	3	5	6	5	3	8

Answers to B:

Row 1	2	4	3	5	3	2	3	5	2
	3	4	1	2	5	5	4	6	1
	5	5	2	6	3	1	2	3	4
Row 2	1	2	15	3	1	20	30	4	1
	10	1	3	25	2	1	1	40	3
	4	5	1	1	5	4	2	1	35

Answers to C:

8	9	4	6	10	5	.51	.39	.99
3	7	11	6	7	8	1.11	.63	.15
10	5	6	9	4	8	.27	.87	.75

5.4	.3	3.6	3.6	.2	2.4
1.2	1.8	2.7	.8	1.2	1.8
.9	10.8	.6	.6	7.2	.4

Variation

Encourage students to construct similar problems with or without hints for others to solve.

Worksheet

Find the Missing Numbers—Adding (A)

Directions: Fill in the squares so that the sum of each row and column of numbers is equal to the outside numbers. Hints about the missing numbers are given for each row.

Hint: In each square, one of the missing numbers is used twice; all answers use numbers 1–7.

Row 1

1			10
		7	13
2			9
7	10	15	

	1		6
4			12
		3	16
14	10	10	

		5	11
2			11
	4		16
12	11	15	

Hint: When you complete these squares, each row will contain 2 odd numbers; select from numbers 1–9.

Row 2

1			14
	3		12
		5	16
5	11	16	

		9	12
	5		16
3			14
9	11	22	

	7		10
	5		12
	3		16
10	15	13	

Worksheet

Find the Missing Numbers—Multiplying (B)

Directions: Fill in the squares so that the outside numbers are the product of all the numbers in the row or column inside the grid.

Hint: In each of these squares, two of the missing numbers are two. The other 4 numbers can be selected from numbers 1, 3, 4, 5, and 6. When it's finished, every square will contain two 3s.

Row 1

		3	24
	4		12
5			50
30	80	6	

5			30
	5		50
6			18
60	45	10	

	5		30
4			24
		4	24
24	90	8	

Hint: Each row in each square contains a one. The other three numbers are 5s or multiples of 5, and they can go as high as 40.

Row 2

	2		30
		3	30
4			20
40	10	45	

3			60
	2		50
		4	20
75	10	80	

	4		120
		3	120
2			70
60	160	105	

Worksheet

Find the Missing Numbers—Adding and Multiplying (C)

Directions: Fill in the numbers so that all three rows, all three columns, and the two diagonals add to 21.

		4
3		
		6

Directions: Use numbers 4 through 10; use each number once. When the square is finished all rows, columns, and the diagonals will add to 21. There will be two 8s and two 6s.

6		
		8

Directions: Fill in the missing numbers so that all rows, columns, and diagonals add to 1.89.

		.99
1.11		
		.75

Directions: Fill in the missing numbers so that the product of all rows, columns, and diagonals is 5.832.

		3.6
1.2		
		.6

Directions: Fill in the missing numbers so that the product of the rows, columns, and diagonals is 1.782.

3.6		2.4
	7.2	

Activity

The Pizza Store

Objective To allow students to discover the rules for determining combinations

Grade Level Grades 6–9

Math Concepts/Skills Determining combinations

Time 3–5 minutes per problem

Materials One copy of the "The Pizza Store" handout on the following page for each group

Procedure Divide students into small groups. Define "combinations," and then let students work in groups to build their own pizzas using the problems outlined on the following page. Ask students to make diagrams to help them find the answers.

Answers:

a. 8 different pizzas

b. 4

c. 24

d. 48

e. The rule is to multiply the number of choices in each category together, i.e., A $= 2 \times 2 \times 2 = 8$, B $= 1 \times 2 \times 2 = 4$, C $= 2 \times 2 \times 2 \times 3 = 24$, D $= 2 \times 2 \times 2 \times 2 \times 3 = 48$.

Handout

The Pizza Store

The pizza store started out with the following menu:

Crusts	*Cheeses*	*Meats*
Thick	Mozzarella	Sausage
Thin	Provolone	Pepperoni

a. If customers choose one kind of crust, one kind of cheese, and one kind of meat on every pizza, how many different kinds of pizza (or combinations) could the pizza store make? (The pizzas have crust on the bottom, cheese in the middle, and meat on the top.)

b. The pizza store owner decided that it was too much trouble to make two crusts, so she would make only thin crust. How many combinations could the store make if customers still choose only one kind of cheese (in the middle) and one kind of meat (on top) on every pizza?

c. After a while, the pizza store owner decided that she would go back to making two kinds of crust, and she would also add three kinds of vegetables—onions, green peppers, and mushrooms—to be placed on top of the meat. Now, if customers choose one kind of crust, one kind of cheese, one kind of meat, and one kind of veggie on each pizza, how many different kinds of pizza could she make?

d. What if the owner decided to have two sizes of pizza—small and large? Now how many different combinations would be possible?

e. Can you figure out a rule for solving these problems?

Resources

Burns, M. 1982. *Math for smarty pants.* Boston: Little, Brown.

This book contains a wide range of accessible activities presented in an entertaining format. It would be particularly useful for expanding upper elementary students' perceptions of mathematics.

Burns, M. 1975. *The I hate mathematics book.* Boston: Little, Brown

For those students who "seemingly" hate mathematics, this book provides many relevant activities to boost confidence and aspirations. Positive attitudes toward mathematics develop as students experiment with and investigate the uses of mathematics in solving everyday problems. The activities are presented in a way that encourages students to have fun with mathematics

Cook, M. *Math materials.* Catalog. Balboa Island, California.

These materials include tiling sets, task cards, and books designed to add variety to math. The materials emphasize problem solving and focus on active student involvement. Also included are several books on cooperative learning. A catalog is available from Marcy Cook, P.O. Box 5840, Balboa Island, CA 92662.

Downie, D.; Slesnick, T.; and Stenmark, J. K. 1981. *Math for girls and other problem solvers.* Berkeley: University of California, Math/Science Network.

The activities in this book encourage independent thinking and creativity in mathematics. Students and teachers are encouraged to think about problem solving in versatile ways and forms. Although this book was originally designed for females, the activities are appropriate and interesting for both boys and girls, ages 7–14. The book would also be an excellent resource for math clubs.

Fraser, S., ed. 1982. *SPACES: Solving problems of access to careers in engineering and science.* Berkeley: University of California, Lawrence Hall of Science.

A collection of thirty-two classroom activities designed to stimulate students' thinking about math-related careers, develop problem-solving skills, and promote positive attitudes toward math. Activities are designed for students in grades 4–10.

Holden, L. 1987. "Math: Even middle graders can learn with manipulatives." *Learning 87* 16, no. 3: 52–55.

Learning fractions can be frustrating; this article includes many ways that manipulatives can be used to help upper elementary students understand fractions and learn geometric concepts.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. The purpose of the program is ultimately to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes sections with activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction.

Overholt, J. L. 1978. *Dr. Jim's elementary math prescriptions.* Santa Monica, CA: Goodyear.

Dr. Jim's elementary math prescriptions is a resource for educators in grades K–8 who are searching for effective methods of teaching mathematics. Each mathematical concept is presented with alternative methods to accommodate students with varied learning styles, abilities, and interests. Selected activities provide enjoyable mastery practice, so that students will develop mathematical competence and appreciation.

Silvey, L., and Smart, J. R. 1982. *Mathematics for the middle grades (5–9).* Reston, VA: National Council of Teachers of Mathematics.

This book was developed to aid teachers in promoting the mathematical development of students in grades 5–9. The three sections of the book cover critical issues in mathematics education, unique learning activities, and strategies for teaching problem solving.

Skolnick, J.; Lan[illegible] C.; and Day, L. 1982. *How to encourage girls in math and science: [illegible] for parents and educators.* Palo Alto, CA: Dale Seymour Publications.

This excellent resource examines the effect of sex-role socialization on girls' math/science skills and confidence. It explains how attitudes, parenting and teaching practices, stereotypical play activities and books, peer pressure, and career and family expectations cause girls to question their abilities in math and science, and thus hinder their development in these areas.

In addition to a summary of the socialization process, this book contains a variety of compensatory educational strategies and activities that may be used to encourage females in mathematics. These particularly focus on increasing math confidence, spatial visualization skills, and problem solving and are designed for primary through junior high school students. Both parents and educators can benefit from this book.

Souviney, R. J. 1981. *Solving problems kids care about.* Palo Alto, CA: Scott, Foresman.

Solving problems kids care about is divided into two parts. Section 1 includes notes and strategies for teaching mathematical problem solving. Section 2 contains thirty selected real-world problems that encourage divergent and logical thinking. Many of the problems have a range of acceptable solutions and multiple solution strategies, so students have the opportunity to be creative, independent thinkers. Activities are designed for elementary through junior high school students; teachers will enjoy them also.

Stenmark, J. K.; Thompson, V.; and Cossey, R. 1986. *Family math.* Berkeley: University of California, Lawrence Hall of Science.

If mathematics promotion is a goal of your teaching, *Family math* activities will help you introduce parents and children to ideas that improve their math skills and help them gain an appreciation for math. Topics are geared to the K–8 math curriculum. Hands-on mathematical experiences provide families an opportunity to develop problem-solving skills by looking for patterns, drawing pictures, working backwards, working cooperatively with a partner, and eliminating possibilities. The

mathematical concepts learned in *Family math* are spatial relationships (geometry), estimation, data interpretation (probability and statistics), and mathematical reasoning.

Wiebe, A., and Hillen, J., eds. 1986. *AIMS Newsletter.* Fresno, CA: AIMS Education Foundation.

This newsletter describes the AIMS (Activities That Integrate Math and Science) Program. The program includes a wide range of science and math activities and focuses on the integration of learning experiences, problem-solving activities, and cooperative learning for grades K–9.

Part 4

Other Issues

This section of the guide contains activities, strategies, and resources to assist you with several areas in which girls often need special help and/or encouragement. These areas are

1. computer access
2. spatial visualization skills
3. test-taking skills

Increasing Computer Access for Girls

We are now witnessing the incorporation of the computer into all aspects of our lives. There are indications that both at school and at home girls have less access to computers than boys. When they do have access, girls are being channeled into lower-level computer activities.

- Girls express less interest than boys in learning about or using computers; they use computers outside of class less than do boys. (Miura 1987)

- Girls have been found to be more reluctant than boys to assume computer leadership roles such as class assistant or tutor. (Bakke et al. 1985)

- When both boys and girls are sharing computers, boys often monopolize the computer, refusing to take turns; girls then become passive rather than active participants. (Schubert 1986)

- Much leisure activity software incorporates violent and competitive war-like games that appeal more to boys than to girls. (Kreinberg et al. 1985)

- Left to their own inclinations, fewer girls will become involved with microcomputers available at school; junior high age girls are often reluctant to compete with boys for computer time. (Boss, cited in Grayson and Martin 1988)

- In California only 37 percent of students enrolled in high school computer programming classes were females; at one university campus, only 27 percent of students who enrolled in computer classes were female. (Linn and Fischer, cited in Grayson and Martin 1988)

- Female enrollment in computer summer camps was only 24 percent in 1982 (Kreinberg et al. 1985). The disparity in male/female computer camp enrollment increases with age and cost. (Hess and Miura, cited in Grayson and Martin 1988)

- There are twice as many boys as girls enrolled in high school computer science courses that teach programming and that lead to careers in computer science and systems analysis; however, in business education courses that offer computer training in word processing and lead to clerical occupations, there are twice as many girls. (Sadker and Sadker 1985)

Because computers are expected to take an increasing role in modern society, it is vitally important that we ensure that girls are being given opportunities to learn to use and enjoy this technology. The strategies and activities on the following pages assume that you have computers available for students in your school.

Before looking through the strategies and activities in this section, you might want to assess the computer learning climate for girls at your school. Answer the following questions:

1. Is there a lack of encouragement for girls to use computers?

2. Is the potential value of computer learning more apparent to boys than to girls?

3. Is there a bias against girls in software and advertising?

4. Does your school have prerequisites that are irrelevant for computer access and instruction (such as math)?

5. Is there limited computer access for girls during free time?

6. Is there underrepresentation of girls in computer leadership roles?

7. Is there dominance by one student over another during computer time? Are the dominant students typically boys?

8. Do you see pressure from girls' peers not to participate in computer activities?

9. Is there underrepresentation of girls in computer clubs?

10. Is there inappropriate location of computers in your school?

11. Is there an inability of teachers and students to recognize and deal with problems in computer learning?

12. Is there a shortage of qualified personnel for computer learning?

13. Is there a shortage of computer time?

14. Is there a shortage of software that is interesting to girls?

The strategies and activities on the following pages include suggestions for dealing with these problems.

Questions 1–12 were reprinted, by permission, from "Educator's self-assessment for equitable computer learning" in *Ideas for equitable computer learning* by Thomas Bakke et al. Copyright 1985 by American Institutes for Research, Palo Alto, California.

Strategies

1. Find out more about the computer gender gap, and be aware of the career implications of computer illiteracy for girls. The resource list at the end of this section contains several informative articles.

2. If your computer center is thought of as primarily a male game-playing area, change that image to one of a learning center for all students.

3. Make sure that you use software that is interesting for girls as well as boys and that teaches students to become problem solvers. Eliminate materials that are primarily oriented toward one sex, such as aggressive games. Use programs that are open-ended and exploratory.

4. Make special efforts to provide access to computers for students who do not have home computers; demonstrate the value of computers by encouraging their use for extracurricular activities.

5. Stress application programs and problem-solving activities rather than pure programming in introductory computer courses. If students see the usefulness of computers first, they will become more interested in learning the mechanics of programming later. Provide a wide range of computer experiences for students. Investigate problem-solving simulation software, such as "Safari Search" or "Teasers by Tobbs" available from Sunburst Communications; spreadsheet and database software, such as Appleworks; and geometry-related software, such as the "Geometric Supposer" programs from Sunburst.*

6. Encourage parents to support both boys' and girls' involvement in computer learning. Parents can form a parent-teacher computer use group to share information; they might also raise funds to purchase computers for schools or to provide further computer education for teachers.

7. Role models are very important. Girls become more interested in computers when they see their mothers using them. Parents might initiate a mother-daughter computer club or investigate a mother-daughter computer class. Also, it is worth noting that every woman profiled in the stories in the role model section of this guide uses computers in her work.

8. Make other special efforts to involve girls in computer learning by developing a computer club for girls and encouraging girls to find friends with whom they can share computer experiences at school or at home.

9. Plan for equal access to and use of computers by boys and girls. In the beginning, this may require you to set aside certain times for "girls only" or to develop other procedures that ensure equal time for both sexes. Use a log-on sheet like the one on the page following this list of strategies.

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* Portions of strategies 2–5 were suggested in "Sex equity: Increasing girls' use of computers" by Lockheed and Frankt, in *Computer Teacher* 11, no. 7: 16–18.

10. Other strategies for equal access include:

    a. Distribute "tickets" of different colors to all students who want to use your computer lab (or who are enrolled in computer classes). Use the ticket colors to regulate access to the lab. For example, students with yellow tickets could be admitted first on Mondays, and students with tickets of other colors could fill any leftover spaces. Students with blue tickets could be admitted first on Tuesdays, etc. You could issue only two colors of tickets and use them on alternate days, before and after school or for the first and second half of the lunch period. Change the pattern often to give everyone a chance.

    b. Reserve some computers for girls and some for boys. You can use this technique on a first-come, first-serve basis during free periods, or you can have students sign up ahead of time.

    c. Set aside one day of the week for boys to use the lab exclusively and another day for girls. It may take some time for students to take advantage of this policy, so give it a trial period of six weeks or more before you decide to alter it. Publicize the policy, and place a poster in the lab to remind students of "Boys Only" and "Girls Only" days.

    d. Alter the environment in the computer lab so that it appeals to all students. If the focus is mainly on males (violent games, male-dominated graphics or art), try to include software activities and bulletin board materials that interest girls as well. Ask the girls to suggest ideas for creating a comfortable environment.

11. To motivate all students to become involved in computer learning, show them how computers are used in the real world. Some strategies include:

    a. Plan field trips to local businesses that use computer technology, so that your students can see what people do with computers, what training and education the employees need, what the job environment is, and what the job satisfaction is. Try to locate nontraditional role models.

    b. Incorporate computer use into other classroom activities such as the school newspaper, recording students' achievements in school sports, keeping track of individual sales for fund-raising activities, and preparing documents for field trips (parent permission slips, instructions to students, guides of "what to look for," etc.).

    c. Work with other teachers and volunteers to design computer activities that demonstrate immediate and long-term relevance. Have each person critique another's ideas. Use these activities to build up the computer center as a school resource for other teachers. Show them what support a computer can be in easing their workload and in providing ways for students to apply their computer skills.

Strategies 10 and 11 were reprinted, by permission, from *Ideas for equitable computer learning* by Bakke et al. Copyright 1985 by American Institutes for Research, Palo Alto, California.

d. Try linking computers to careers so that students must think ahead and analyze how they might use their computer skills in the future. Ask students to write a three-part essay or give a talk dealing with these ideas: (a) What I Plan to Do in the Future, (b) What Role Will a Computer Probably Play in This Plan, and (c) How I Can Prepare for That Career. If there are students who do not believe that the computer will affect their careers, use those careers as the basis for a discussion, and have the class talk about possible computer uses.

e. As part of an assignment, have advanced students suggest class activities that require the practical application of computer technology. Have students share the better ideas with the rest of the class. Try out and refine these ideas for use with future classes.

12. Obtain a copy of *Ideas for equitable computer learning* by Bakke et al. (see the resource list at the end of this section) for a number of excellent strategies to overcome dominance by one student over another during computer time, lack of encouragement for female and minority students to use computers, under-representation of females in computer leadership roles, and inability of teachers and students to recognize and deal with problems in computer learning.

13. Use a variety of grouping techniques and types of programs when working with students and computers. For example:

    a. If students are working *individually*, use *drill and practice*, *tutorial*, or *problem-solving* programs. The advantage of individual grouping is that each student controls the content and pace of learning.

    b. If students are working in *small groups*, use *simulations*, *educational games*, and *problem-solving* programs. One of the advantages is that students learn cooperative skills.

    c. If students are working in a *large group*, use *demonstrations of problem solving* with a monitor and a TV screen. With this method all students can receive and view the explanation at one time.

Handout

Computer Log-On

Sign-up Sheet for the Week of

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7:40-8:00					
8:00-8:20					
8:20-8:40					
8:40-9:00					
9:00-9:20					
9:20-9:40					
9:40-10:00					
10:00-10:20					
10:20-10:40					
10:40-11:00					
11:00-11:20					
11:20-11:40					
11:40-12:00					
12:00-12:20					
12:20-12:40					
12:40-1:00					
1:00-1:20					
1:20-1:40					
1:40-2:00					
2:00-2:20					
2:20-2:40					
2:40-3:00					
3:00-3:20					
3:20-3:40					
3:40-4:00					

Directions: Every week post a copy of this sheet in your computer area. The sheet can be used to sign up whole classes or individual students for computer time. Put an X through inconvenient time slots. Make sure everyone has fair access to the computers each week.

General Computer Information

Types of Software Programs

1. Drill and Practice
   a. tailor instructions to individual students
   b. provide for random selection
   c. give immediate reinforcement

2. Tutorial
   a. tailor instructions to individual students
   b. introduce new concepts
   c. give immediate reinforcement

3. Simulations
   a. approximate real events
   b. compress years into minutes
   c. test hypotheses

4. Problem Solving
   a. work with data
   b. perform rapid calculations
   c. systematize information

5. Educational Games
   a. motivate
   b. present basic facts in new ways
   c. develop logical guessing

Tips on Selecting Software*

Answer the following questions:

1. Will it run on our computers?
2. Is it the content appropriate?
3. Is it right for this grade level?
4. Is it the correct type of program?
5. Does it match the lesson objectives?
6. Will it work in this classroom situation?
7. What does it cost?
8. Does the company provide a free back-up copy?
9. Is there on-site preview of software available?
10. Does the company's copyright provide for multiple copies?

* Tips collected by Christine Huss, Nevada Department of Education, Carson City, Nevada. Used by permission.

Examples of Highly Rated Software

Balance! (Grades 8+). HRM/Queue, 1985. Helps students visualize and understand the process of solving equations. Linear equations are graphically displayed on a balance beam; students manipulate the value of a variable and immediately see the effect on the balance.

Building Perspective. (Grades 4–12). Sunburst Communications, 1986. Assists students in thinking spatially and fosters cooperative learning and teamwork. Students view buildings from the side and try to predict how they will look from the top.

Function Machine: Level 2. (Grades 7–9). D. C. Heath/Collamore, 1986. An educational game that helps students understand numeric relationships. Students try to discover the Wizard's rule governing output as they feed numbers into a "function machine."

Geometric Presupposer. (Grades 5+). Sunburst Communications, 1985. This program allows students to measure lengths, angles, areas, and circumferences. The objective is to help pregeometry students master the concepts of congruences, similarities, and parallelism. Younger students also learn to name and construct simple shapes.

Guess My Rule. (Grades 6+). HRM/Queue, 1985. Helps students think logically by working with equations and graphs. Suitable for students in prealgebra through precalculus.

Sampling: Probability and Prediction. (Grades 7–9). D.C. Heath/Collamore, 1986. A simulation program to help students develop an understanding of statistical analysis and the effects of sample size in a variety of interesting settings.

Problem-Solving Courseware: Levels 5–8. (Grades 5–8). Tom Snyder Productions, 1987. A simulation in which students are encouraged to use math problem-solving techniques in an adventure game format.

Royal Rules. (Grades 6+). Sunburst Communications, 1987. An educational game that teaches students about the generation and testing of hypotheses.

Sources of Courseware Information

Educational Computing Magazines

Electronic Learning
Teaching and Computers
The Computing Teacher
Classroom Computer Learning
Educational Technology
The Mathematics Teacher
The Arithmetic Teacher

Software/Courseware Reviews

TESS: The Educational Software Selector. Educational Products Information Exchange (EPIE) Institute. Teachers College Press, New York, NY 10016 (annual publication)

EPIE Micro-Courseware PRO/FILES. Educational Products Information Exchange Institute, P.O. Box 839, Water Mill, NY 11976

Microgram: The Educational Software Newsletter of the EPIE Institute. Educational Products Information Exchange Institute, P.O. Box 839, Water Mill, NY 11976 (published monthly, with nine issues per year)

Only the Best: The Discriminating Software Guide for Preschool–Grade 12. Linda Mattas, Editor, Educational News Service, P.O. Box 1789, Carmichael, CA 95609 (annual publication)

Digest of Software Reviews: Education. Ann Lathrop, Editor, 1341 Bulldog Lane, Suite C, Fresno, CA 93710 (serial)

Software Reports: Guide to Evaluated Educational Software. Trade Service Publications, Inc., 10996 Torreyana Road, San Diego, CA 92121 (serial)

Software Reviews on File: Education. James Johnson, Editor, Facts on File, 460 Park Avenue South, New York, NY 10016 (serial)

Good Sources of Software/Courseware

Minnesota Educational Computing Consortium (MECC), 3490 Lexington Avenue North, St. Paul, MN 55126

Sunburst Communications, 39 Washington Avenue, Pleasantville, NY 10570–9971

The Learning Company, 6493 Kaiser Drive, Fremont, CA 94555

Activity

Logo Hit-the-Spot

Objective

To teach students the skill of moving a computer representation various directions and distances; to help students learn spatial orientation

Grade Level

Grades 6–9

Math Concepts/Skills

Using computers, spatial visualization

Time

15–30 minutes per session

Materials

Logo software, program listing (see following pages)

Procedure

Enter, or have one student enter, the appropriate program listing on to the computer. Save the entered listing on a disk, and then load it into all of your students' computers. Or, you can duplicate the *appropriate program listing* (only), and let students, individually or in pairs, enter it into their computers. If you have students enter the program, be sure they type in the listing *exactly* as shown, including the START, BOX, PLACEBOX, PLACETURTLE, CRAWL, and CHECK procedures. Use the correct version for your Logo program. (Note that Terrapin Logo uses the MIT version.)

The program places a box and the turtle at random on the screen. Students use single keystroke commands to move the turtle inside the box. These single keystroke commands are programmed into the computer by the CRAWL procedure (as listed on the program directions), which changes regular Logo commands into single keystroke commands. The students type F to move the turtle 10 steps forward, B to move 10 steps back, L to turn left 15 degrees, and R to turn right 15 degrees.

To begin the game, the students type in START and press RETURN or ENTER. START is the master procedure. After clearing the screen, START calls upon the PLACEBOX procedure to draw a box somewhere and record the coordinates (x and y) of the box's lower left corner in the computer's memory. PLACETURTLE then positions the turtle at a random location with a random heading.

CRAWL contains instructions to change regular Logo commands into single keystroke commands (a procedure called INSTANT). The procedure also contains a CHECK to see if the turtle is in the box. If it is, the computer prints "You Win!" on the bottom of the screen.

Handout

Program Listing for Hit-the-Spot

Follow the steps for typing in the procedures for "Hit-the-Spot."

1. Type in the version of the START procedure for your Logo program.

MIT and Apple Versions:
```
TO START
CLEARTEXT
HOME CLEARSCREEN
PLACEBOX
PLACETURTLE
CRAWL
END
```

TI Versions:
```
TO START
TELL TURTLE
HOME CLEARSCREEN
PLACEBOX
PLACETURTLE
CRAWL
END
```

2. Type in the BOX procedure exactly as shown.

All Versions:
```
TO BOX
REPEAT 4 [FD 25 RT 90]
END
```

3. Type in the version of the PLACEBOX procedure for your Logo program.

MIT Version:
```
TO PLACEBOX
RANDOMIZE
PENUP
SETX (110-RANDOM 240)
SETY (90-RANDOM 160)
PENDOWN
BOX
PENUP
MAKE "X XCOR
MAKE "Y YCOR
HOME PENDOWN
END
```

TI Version:
```
TO PLACEBOX
PENUP
SX (90-20*RANDOM)
SY (45-10*RANDOM)
PENDOWN
BOX
PENUP
MAKE "X XCOR
MAKE "Y YCOR
HOME
PENDOWN
END
```

Apple Version: Omit the word RANDOMIZE from the MIT PLACEBOX version.

4. Type in the version of the PLACETURTLE procedure for your Logo program.

MIT Version:
```
TO PLACETURTLE
PENUP
RANDOMIZE
SETX (110-RANDOM 240)
SETY (90-RANDOM 160)
SETHEADING RANDOM 360
END
```

TI Version:
```
TO PLACETURTLE
PENUP
SX (90–20*RANDOM)
SY (45–10*RANDOM)
SET HEADING 40*RANDOM
PENDOWN
END
```

Apple Version: Omit the word RANDOMIZE from the MIT PLACETURTLE version.

5. Type in the version of the CRAWL procedure for your Logo program.

MIT and TI Versions:
```
TO CRAWL
MAKE "KEY RC
IF :KEY = "F FORWARD 10
IF :KEY = "B BACK 10
IF :KEY = "L LEFT 15
IF :KEY = "R RIGHT 15
MAKE "IN.BOX CHECK
IF :IN.BOX? = "TRUE PRINT [YOU WIN!] STOP
CRAWL
END
```

Apple Version:
```
TO CRAWL
MAKE "KEY RC
IF :KEY = "F [FORWARD 10]
IF :KEY = "B [BACK 10]
IF :KEY = "L [LEFT 15]
IF :KEY = "R [RIGHT 15]
MAKE "IN.BOX CHECK
IF :IN.BOX? = "TRUE [PRINT [YOU WIN!] STOP]
CRAWL
END
```

6. Type in the version of the CHECK procedure for your Logo program.

MIT AND TI Versions:
```
TO CHECK
IF (XCOR > :X+25) OUTPUT "FALSE
IF (XCOR < :X) OUTPUT "FALSE
IF (YCOR > :Y+25) OUTPUT "FALSE
IF (YCOR < :Y) OUTPUT "FALSE
OUTPUT "TRUE
END
```

Apple Version:
```
TO CHECK
IF (XCOR > :X+25) [OUTPUT "FALSE]
IF (XCOR < :X) [OUTPUT "FALSE]
IF (YCOR > :Y+25) [OUTPUT "FALSE]
IF (YCOR < :Y) [OUTPUT "FALSE]
OUTPUT "TRUE
END
```

Variation: To make the computer game more challenging, reduce the size of the box. Do this by entering a smaller FD input number in the BOX procedure. Enter the same number in place of the existing number in the CHECK procedure.

Activity

Logo Warmer or Cooler

Objective Students try to find a secret location, based on feedback from the computer

Grade Level Grades 6–9

Math Concepts/Skills Using computers, spatial visualization

Time 15–30 minutes per session

Materials Logo software, program listing (see following page)

Procedure To play the game on the computer, type in the appropriate program listing, including START2, DISTANCE, SETPOINT, HUNT, and PLACETURTLE (from "Logo Hit-the-Spot" activity). Save the listing on a disk, and load it into students' computers. START2, the main procedure, uses SETPOINT to select a secret location and PLACETURTLE to give the turtle a random location and heading. DISTANCE calculates the distance between the turtle and the secret location. HUNT accepts Logo turn and movement commands and continually checks to see if the turtle is coming closer to the target. The computer generates "Warmer" or "Cooler" messages depending on whether the turtle is closer to or farther from the target.

The program is not very "bullet-proof," however. If the student types FD45 instead of FD 45, the program stops and generates an error message. To resume the activity after an error message, students must type in HUNT. As students play "Warmer or Cooler," watch for inward spiral patterns as the turtle closes in on its target.

This activity was drawn from "Logo notebook" by T. Lough and S. Tipps, in *Teaching and Computers*, November/December 1983.

Handout

Program Listing for Warmer or Cooler

Follow the steps for typing in the procedures for Warmer or Cooler.

1. Type in the version of the START2 procedure for your Logo program.

MIT and Apple Versions:

```
TO START2
CLEARTEXT
HOME CLEARSCREEN
SETPOINT
PLACETURTLE
MAKE "D DISTANCE:X:Y
HUNT
END
```

TI Version:

```
TO START2
TELL TURTLE
HOME CLEARSCREEN
SETPOINT
PLACETURTLE
MAKE "D DISTANCE:X:Y
HUNT
END
```

2. Type in the version of the DISTANCE procedure for your Logo program.

MIT and Apple Versions:

```
TO DISTANCE:X:Y
MAKE "X.SQUARED (XCOR-:X)*(XCOR-:X)
MAKE "Y.SQUARED (YCOR-:Y)*(YCOR-:Y)
MAKE "HOWFAR SQRT (:X.SQUARED + :Y.SQUARED)
OUTPUT :HOWFAR
END
```

TI Version:

```
TO DISTANCE:X:Y
MAKE "X.SQUARED (XCOR-:X)*(XCOR-:X)
MAKE "Y.SQUARED (YCOR-:Y)*(YCOR-:Y)
OUTPUT (:X.SQUARED + :Y.SQUARED)
END
```

3. Type in the version of the SETPOINT procedure for your Logo program.

MIT Version:

```
TO SETPOINT
RANDOMIZE
MAKE "X (110-RANDOM 240)
MAKE "Y (90-RANDOM 160)
END
```

TI Version:

```
TO SETPOINT
MAKE "X (90–20*RANDOM)
MAKE "Y (45–10*RANDOM)
END
```

This activity was drawn from "Logo notebook" by T. Lough and S. Tipps, in *Teaching and Computers*, November/December 1983.

Apple Version: Omit the word RANDOMIZE from the MIT version.

4. Type in the version of the HUNT procedure for your Logo program.

MIT and TI Versions:

```
TO HUNT
RUN REQUEST
MAKE "D1 DISTANCE:X:Y
IF :D1 < 10 PRINT [YOU GOT IT! ] STOP
IF :D-:D1=0 PRINT [NO TEMPERATURE CHANGE]
IF :D-:D < 0 PRINT [YOU'RE GETTING COOLER!]
IF :D-:D > 0 PRINT [YOU'RE GETTING WARMER!]
PRINT[ ]
MAKE "D:D1
HUNT
END
```

Apple Version:

```
TO HUNT
RUN READLIST
MAKE "D1 DISTANCE:X:Y
IF :D1 < 10 [PRINT [YOU GOT IT!] STOP]
IF :D-:D1=0 [PRINT [NO TEMPERATURE CHANGE]]
IF :D-:D < 0 [PRINT [YOU'RE GETTING COOLER!]]
IF :D-:D > 0 [PRINT [YOU'RE GETTING WARMER!]]
PRINT[ ]
MAKE "D:D1
HUNT
END
```

5. Type in the PLACETURTLE procedure from the Logo Hit-the-Spot listing in the previous activity.

Variation: Place the secret location in a maze or city map transparency taped to the screen so that the turtle is confined to streets or paths.

Activity

Arithmetic Operations on the Computer

Objective	To familiarize students with the way a computer carries out arithmetic operations in BASIC programming language
Grade Level	Grades 6–9
Math Concepts/Skills	Using computers, whole numbers
Time	30 minutes
Materials	"Arithmetic Operations" handout on the following page (one copy per student)
Procedure	The activity sheet is written under the assumption that your students have already been introduced to BASIC. Although the exercise is fairly self-explanatory, you may want to put a few examples on the board and work through them with the whole class.

Handout

Arithmetic Operations

Directions: Match the name of an arithmetic operation with the arithmetic symbol used in BASIC.

ADD	-
SUBTRACT	^
MULTIPLY	+
DIVIDE	*
EXPONENT	/

The computer uses this hierarchy of operations when it evaluates an arithmetic expression:

1. Exponentiation (raising to a power)
2. Multiplication and division
3. Addition and subtraction

Computers do arithmetic in a left to right order.

If you type: PRINT 6 – 4 + 2. The computer will display the number 4 when you press RETURN. Parentheses can be used to change the order in which the computer processes an arithmetic expression.

Example: PRINT 6 – (4 + 2)

Challenge

Use any combination of arithmetic symbols in the PRINT statement given below to make the computer output the number 100.

PRINT 1 2 3 4 5 6 7 8 9

Type each PRINT statement at the computer. Write the output in the space to the right.

1. PRINT 1+2*3+4
2. PRINT (1+2)*3+4
3. PRINT ((1+2)*3)+4
4. PRINT (1+2)*(3+4)
5. PRINT 33/3+8
6. PRINT 33/(3+8)
7. PRINT 15*6+8
8. PRINT 15*(6+8)

Activity

How Big Is a Million?

Objective To help students comprehend large numbers by programming a computer to count

Grade Level Grades 6–9

Math Concepts/Skills Using the computer

Time 20 minutes or longer (You can leave the computer running while the class does other things.)

Materials BASIC program listed below

Procedure Make a copy of the program listing for all students, or put it on an overhead projector. The program, which is written to run on most computers, instructs the computer to count to any specified number. By observing elapsed time, students can get a feel for the relative size of a very large number.

Since the speed at which it counts will vary depending on your particular computer, first have students ask the computer to count to 100 and see how long that takes. Then ask each student to write down their estimate of the time it will take the computer to count to one million.

How Big Is a Million BASIC Program

Load the BASIC program listed below into your computer. When the computer asks, "To what number would you like me to count?", put in 1,000,000, hit Return, and wait. Exactly how long do you think it will take? How long did it take?

```
10 REM
20 REM
30 PRINT "TO WHAT NUMBER WOULD YOU LIKE ME TO COUNT";
40 INPUT N
50 FOR J=1 TO N
60 PRINT J
70 NEXT J
80 END
```

Optional: Make a flow chart to show how the program operates.

Activity

Arithmetic Drill

Objective

To give students practice using simple BASIC programs, to help them explore the logic of a simple computer program

Grade Level

Grades 7–9

Math Concepts/Skills

Using computers

Time

45 minutes

Materials

"Basic Arithmetic Drill" handout on the following page (one copy per student)

Procedure

This simple interactive program allows students to practice adding skills; it selects numbers between 1 and 10 and asks students to give the total. After the program has been entered and used, students are asked to modify the old or write new programs that include larger numbers and different arithmetic operations. Instead of having students spend time loading the program, you could enter it, save it on a disk, and then load it for all students. This would leave more time to explain and discuss the program, try it, and modify it to include larger numbers and different operations.

Handout

Basic Arithmetic Drill

Try this program.

```
100 REM     **********************
110 REM     * ARITHMETIC DRILL *
120 REM     **********************
130 REM
140 REM
150 REM
160 LET A = 0: REM FIRST NUMBER
170 LET B = 0: REM SECOND NUMBER
180 LET C = 0: REM SUM OF A AND B
190 LET X = 0: REM USER'S NUMBER
200 LET N = 0: REM COUNTER
210 REM
220 REM
230 REM
240 REM     *** PICK RANDOM NUMBERS
250 REM
260 LET A = INT ( RND (1) * 10) + 1
270 LET B = INT ( RND (1) * 10) + 1
280 REM
290 REM
300 LET C = A + B
310 REM     *** DISPLAY PROBLEM AND GET ANSWER
320 REM
330 PRINT
340 PRINT A;" + ";B;" = ";
350 INPUT X
360 REM
370 REM     *** CHECK
380 REM
390 IF X = C THEN 420
400 PRINT "WRONG"
410 GOTO 340
420 PRINT "CORRECT"
430 N = N + 1
440 IF N < 10 THEN 260
450 PRINT "YOU HAVE COMPLETED TEN PROBLEMS."
460 END
```

Notice how the IF. . . THEN statement is used to make the computer print "CORRECT" when the value of X is equal to C. Make a flow chart to show the logic of this program.

How could the program be modified to select larger numbers? Modify and run the program again. How could the program be modified to subtract, multiply, or divide? Write a new program that lets you practice one of these operations.

Resources

Bakke, T.; Campbell, E.; Carr, N.; DuBois, P.; Eaton, M.; Kelley, B.; Reller, D.; Schubert, J.; and Wolman, J. 1985. *IDEAS for equitable computer learning.* Palo Alto, CA: American Institutes for Research.

IDEAS is designed to help educators improve computer learning opportunities for all students. This packet of materials includes strategies to counteract problem areas in computer education; a computer survey; a self-assessment checklist for teacher bias; and a bibliography of references on gender equity, computer education, and acceptance and use of computers by females.

Concoran, A. 1989. "Software that helps develop critical and analytical math skills." *Electronic Learning* 9, no. 1: 50–52.

This article describes a number of software programs for grades K–12 that foster the following: critical thinking through the use of manipulatives, an analytical approach to problem solving, understanding through visual presentation of mathematical principles, and understanding of real-world applications of mathematical skills and thinking.

Erickson, T. 1986. *Off and running: The computer off-line activities book.* Berkeley: University of Califomia, Lawrence Hall of Science.

Off and running was developed to encourage minority and female interest in computers, math-based fields of study, and math-related careers. The content of the book includes on-line and off-line activities that teach computer concepts and skills. Activity themes focus on learning programing skills, cooperative learning, and equity in computer usage. This book has coupled excellent educational materials with strategies to promote equity. Content is suitable for grades 5–12.

Hanson, V. P., and Zweng, M. J., eds. 1984. *Computers in mathematics education.* Reston, VA: National Council of Teachers of Mathematics.

This 1984 yearbook was developed by the National Council of Teachers of Mathematics to help teachers integrate computers into the mathematics education program in grades K–12. Issues involved in using the computer as a teaching aid are discussed.

Kreinberg, N., ed. 1977. *I'm madly in love with electricity and other comments about their work by women in science and engineering.* Berkeley: University of California, Lawrence Hall of Science.

This interesting and inspiring book includes selected comments about their work from women scientists, engineers, and mathematicians. Comments are organized into sections about careers in math, engineering, physics, astronomy, chemistry, and life sciences.

Kreinberg, N.; Alper, L.; and Joseph, H. 1985. "Computers and children: Where are the girls?" *PTA Today* 10, no. 5: 13–15.

This informative article explains the importance of computer education and how parent groups may support teacher and school efforts for developing a quality computer education program. The article also lists resources for computer education programs.

Lockheed, M. E., and Frankt, S. B. 1984. "Sex equity: Increasing girls' use of computers." *Computing Teacher* 11, no. 7: 16–18.

This article explains gender inequities in computer education and suggests four changes for classrooms and curricula that will encourage increased female participation.

Miller, I. 1984. "How schools become computer literate: And guidelines on how to evaluate educational software." *Popular Computing* 3, no. 13: 22–23, 26–28.

This article includes a set of recommendations for school computer programs and guidelines for evaluating educational software.

Ventura, F. 1984. *A bite of BASIC*. Palo Alto, CA: Dale Seymour Publications.

This book is a collection of hands-on computer activities with black-line masters and an instructional guide for teachers. The lessons provide experience with computer concepts and teach the commands used in BASIC programming for students in grades 7–12.

Watt, D. 1984. "Update on Logo." *Popular Computing* 3, no. 12: 66–69.

In the past, Logo has primarily been advertised as a programming language that users discover on their own. Recent research has shown that to use Logo effectively, teachers must thoroughly understand Logo well enough to encourage and guide students. This reference contains a list of Logo software and resource materials that the classroom teacher will find helpful.

Improving Spatial Visualization Skills

Spatial visualization involves the visual imagery of objects as they are rotated, reflected, and/or translated—in other words, the mental manipulation of objects and their properties. Although the results are not entirely consistent, many investigators have found that junior high and high school boys perform better than girls on spatial visualization measures. The magnitude of this difference varies according to many factors, including students' personality characteristics, previous experience with spatial activities, and the particular test given. Evidence on how spatial visualization skills affect mathematics achievement is mixed, but many investigators believe that increased training and early experience with spatial visualization can help girls, especially in geometry.

- Fennema and Ayer (1984) concluded that if spatial visualization skills do affect the learning of mathematics, the influence must be extremely subtle; however, other researchers have found strong relationships between spatial skills and mathematics achievement test scores. (Stage et al. 1985)

- Relatively large sex differences have been found on a test measuring the rotation of objects in three-dimensional space. (Sanders et al., cited in Chipman and Wilson 1985)

- Exposure to different toys and recreational activities has been linked to sex differences in spatial skills (Stage et al. 1985). Math readiness is linked to preschool games and toys (blocks, construction sets, cars, tools, etc.) that lead to an understanding of shapes and how things work. Males tend to have had more experience with these types of toys than females have. (Grayson and Martin 1988)

- There is much evidence that spatial visualization skills can be trained (Stage et al. 1985); yet, this type of training is not usually made a part of the mathematics curriculum. (Fox 1981)

- Spatial visualization skills that require students to select three-dimensional shapes that would be formed by folding two-dimensional shapes have been found to be strongly related to mathematics achievement. (Chipman and Wilson 1985)

The activities on the following pages are designed to give all students, but especially female students, some of the practice and experience they need to sharpen their spatial visualization skills. It is important to begin this training at an early age, while girls are still performing on a par with boys.

Strategies

The components of spatial visualization skills include memory of shapes, figure completion, mental rotation of objects, finding hidden shapes, and the creation of three-dimensional objects from two-dimensional patterns. The first six strategies below, which will allow students to practice each of these skills, were suggested in Blackwell's *Spatial encounters* workbook (see resource list following this section).

1. To help with memory of shapes, let students try to draw familiar objects from memory or look at a picture and then try to remember the exact details of its shapes.

2. To help with figure completion skills, encourage students to work jigsaw puzzles or visualize shapes in clouds.

3. To help with mental rotation of objects, students can make stick figures of geometric shapes with Tinkertoys or toothpicks and observe how figures look when turned around.

4. To help with spatial memory and rotation, let students practice visualizing what is behind them. Have them make a sketch and then check. Also, studying a single picture and then trying to draw it as if it had been rotated 90 to 180 degrees is a good exercise.

5. To help with the ability to locate hidden shapes students can try to distinguish geometric shapes in simple pictures or even the clouds. They can also look for common shapes in everyday objects and in stylized artwork.

6. To help with the ability to go from two-dimensional to three-dimensional space, students can assemble models.

7. Use house plans to help students learn informal geometry concepts.

8. Use a copy of Blackwell's *Spatial encounters* to allow students to practice the various component skills that constitute spatial visualization.

9. Make sure that the girls in your classes use manipulative materials as much as the boys. To encourage girls to use manipulatives, model that behavior.

10. In high school geometry, students organize and structure their spatial experiences. Few elementary math curricula stress informal geometry. Research findings indicate that pre-geometry high school students exhibit many misconceptions about shapes. The article by Burger (see the resource list) provides several suggestions for activities that will help junior high students become familiar with informal geometric concepts and prepare them for the study of geometry.

Activity

Jigsaw Geometry

Objective To allow students to identify and work with geometric shapes

Grade Level Grades 6–9

Math Concepts/Skills Geometry, spatial visualization

Time 20–30 minutes (could also be used as a take-home activity)

Materials Paper, colored pens, laminating equipment

Procedure Have students start with a blank 8" x 11" piece of paper. Use a ruler and draw 10–30 straight lines (more or less depending on the level of difficulty required in the puzzle). See examples of a 10-line and 30-line puzzle on the following page.

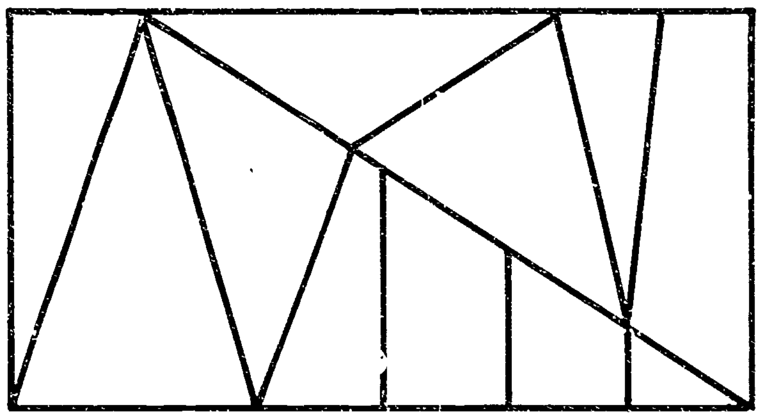
Ask students to estimate the lowest number of different colors it would take to color the individual shapes in the puzzles so that no shape was touching one of the same color. (The answer for most puzzles is 4.) Let them work with their drawings and colored pens to verify their estimates.

Copy or trace each drawing so there will be a record of the solution. Then laminate the puzzles, cut the pieces, and put them in envelopes. Have students identify the shape of each different piece of their own puzzles, noting the number of pieces of each shape in their puzzle.

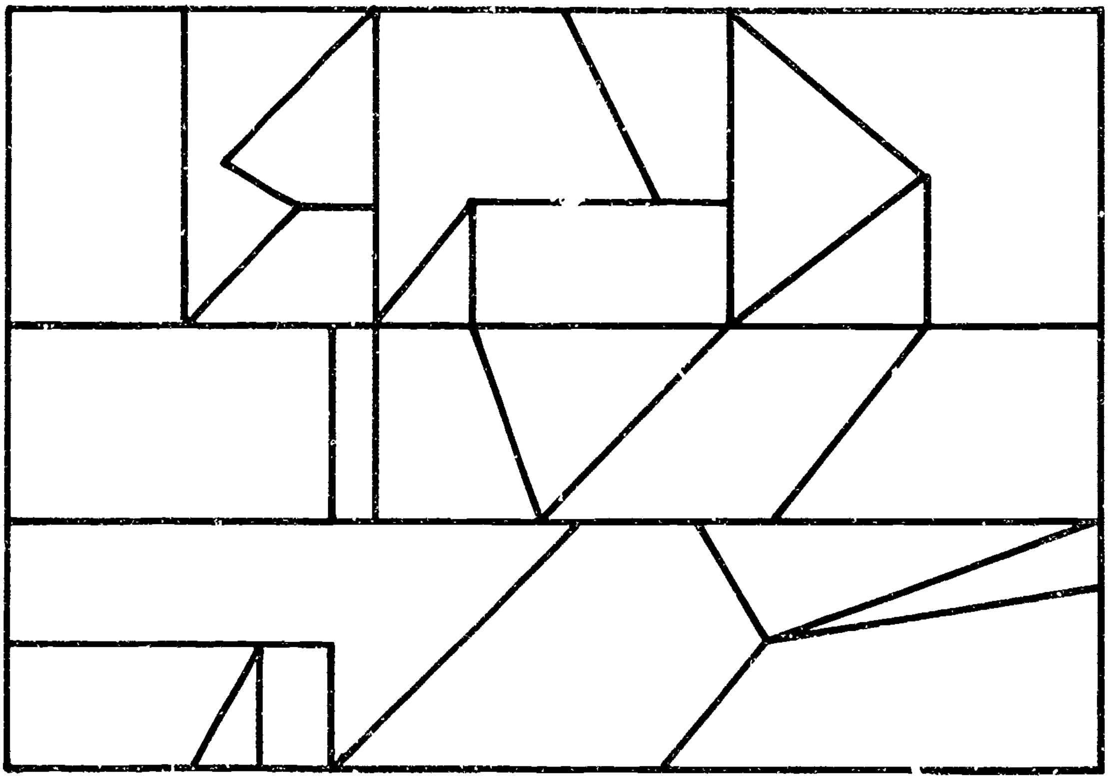
These home-made puzzles can be used at a learning center in assigned or free-time activities. Increase or decrease the level of difficulty of the puzzle by having more or less puzzle pieces. Brighten up the pieces with marking pens or crayons before laminating.

Variation Require students to construct puzzles that contain only one shape (e.g., triangle) or a limited number of shapes (e.g., only four- or five-sided shapes).

10-Line Puzzle



30-Line Puzzle



Activity

Dice Patterns

Objective

To practice spatial visualization skills by constructing a pattern for a three-dimensional object

Grade Level

Grades 6–9

Math Concepts/Skills

Geometry, spatial visualization

Time

Variable—up to 25 minutes

Materials

Heavy paper or cardstock, transparent tape, scissors, dice

Procedure

This activity may be done by students individually or in two- or three-person groups. Give each group a. .east one die. Ask students to observe the dice carefully. Do all of the dice have the same pattern of dots on their sides (that is, the one opposite the six, the two opposite the five, and the three opposite the four)? Is there a pattern in the patterns (opposite sides always add to seven)?

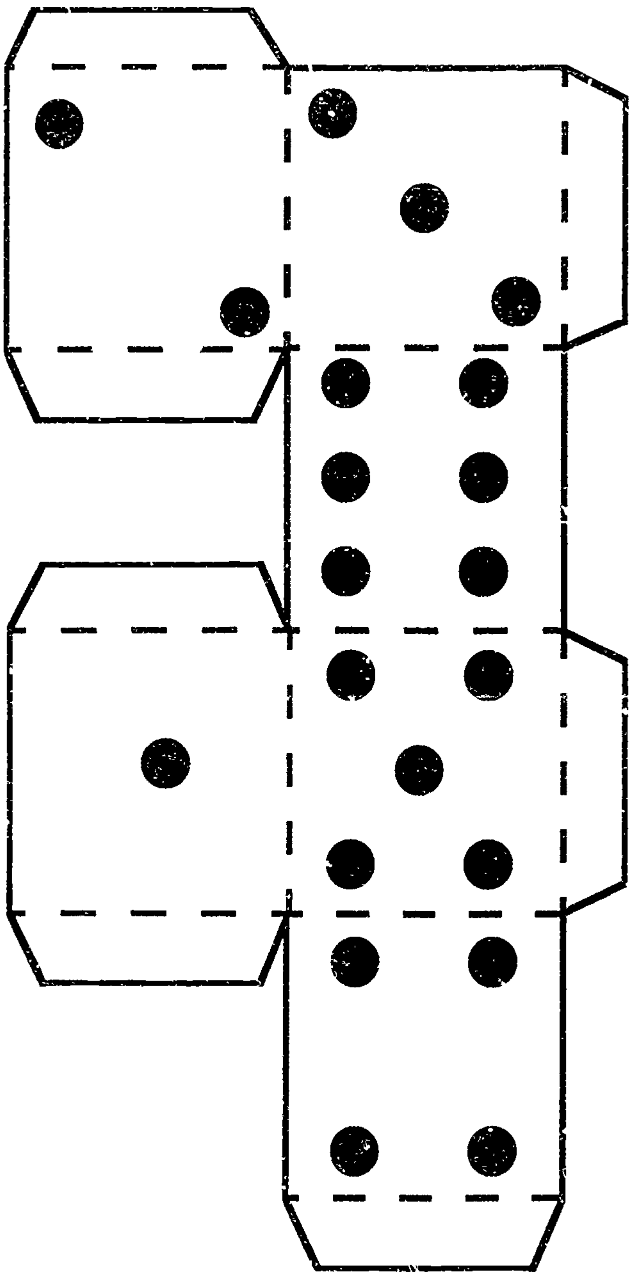
After students have observed the dice, ask them to draw patterns that can be cut out and folded into cubes with the correct dice patterns on their sides. (The patterns should be continuous shapes that form cubes by folding rather than separate pieces that must be glued together.) Some examples of dice patterns are shown on the following pages. Note that "C" is the only pattern that can be shaped into a cube. Have students verify their patterns by cutting each of them out of heavy paper or cardstock, then have students fold, shape, and tape the dice patterns together.

Ask students to compare the cubes. How many different shaped patterns were developed? What commonalities can be found in the successful patterns?

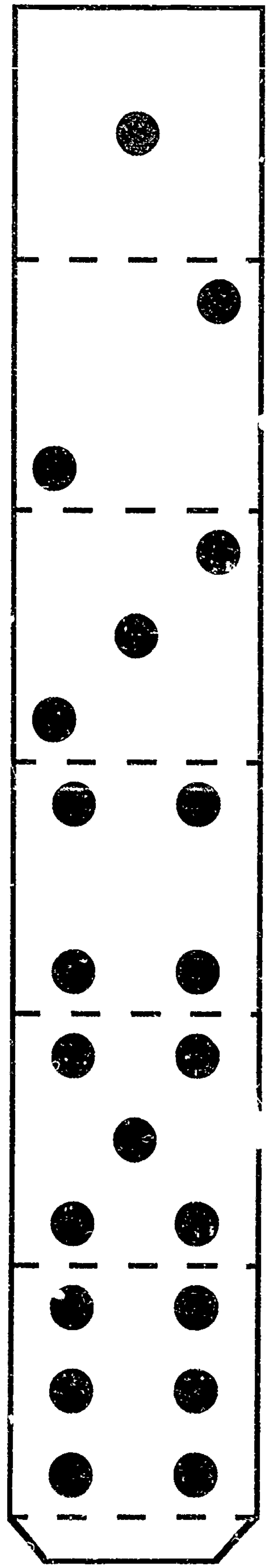
Variation

Let students design and verify their own patterns for other three-dimensional objects.

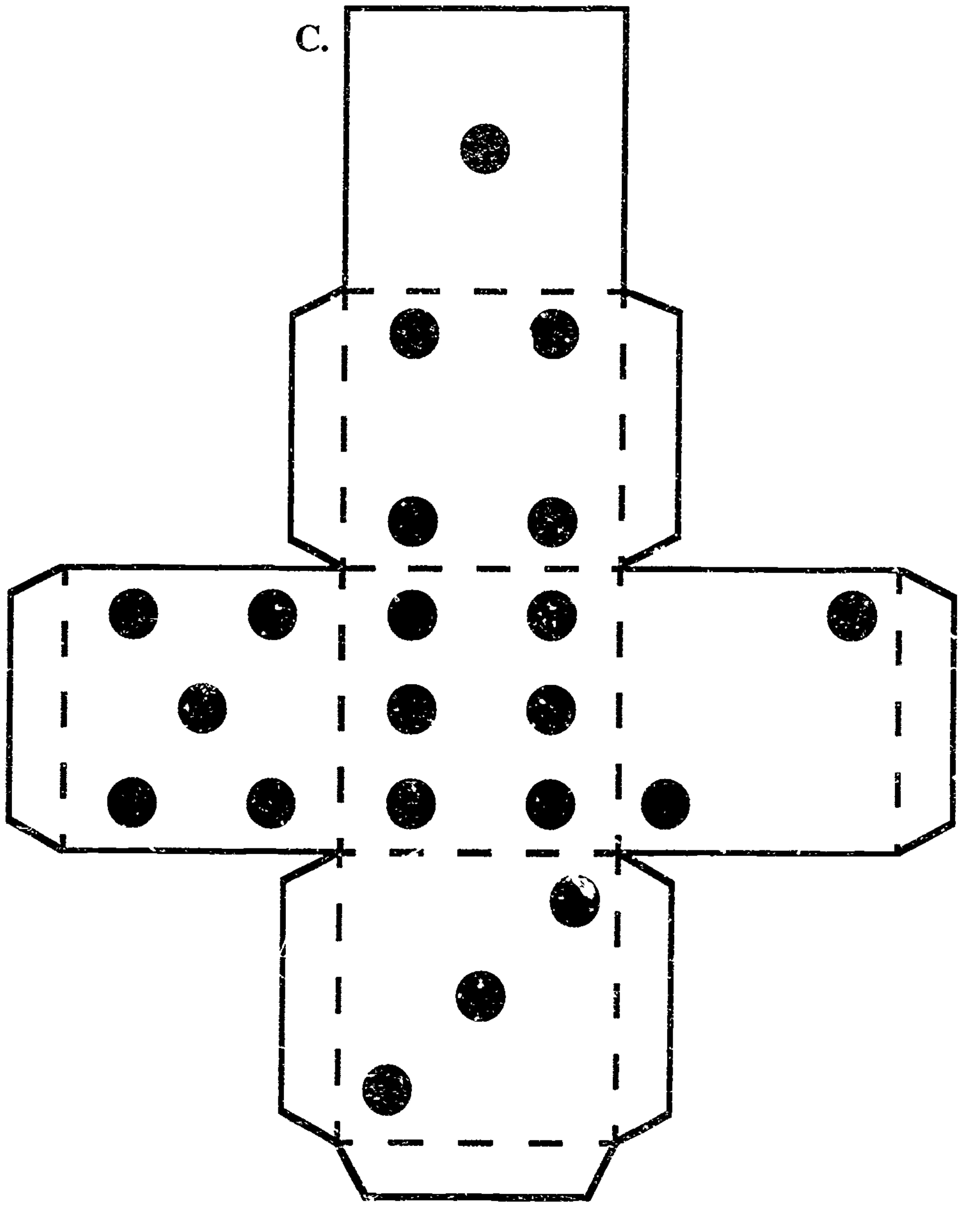
A.



B.



C.



Activity

Spatial Creatures

Objective

To allow students to practice using attribute identification and logical reasoning to classify shapes

Grade Level

Grades 6–9

Math Concepts/Skills

Spatial visualization

Time

30 minutes

Materials

"Spatial Creatures" worksheet on the following pages

Procedure

Give each student or pair of students a set of worksheets. The first sheet illustrates the process. The task is *to find the characteristic or characteristics that distinguish the creatures from one another.* In the first few problems, there is only one defining characteristic. Most problems describe creatures with two unique characteristics. The last few problems describe creatures with three characteristics.

Answers:

a. POLYGONS—straight lines

b. GREEPS—nonstraight lines

c. BYCLOPS—two eyes

d. PRICKALEEPS—prickly skin and one forked tail

e. CLIPPAWAS—shaded and one eye

f. GLIFFAHUMPHS—two eyes and three bumps

g. LIMADROOPS—three eyes and two appendages: one appendage is four hairs and the other is an arrowed tail

h. HEFFALIPPI—shaded, whiskers, one triangular eye (same height)

i. LUMS—one eye and straight lines or three eyes and curved lines

Variation

Students can design their own spatial creatures for others to identify. They should begin their designs by sticking to one characteristic, to become familiar with the process. This can easily be made more challenging by requiring shapes with several distinguishing characteristics for higher level students.

Worksheet

Spatial Creatures

As training for future spaceflights, here's your chance to practice identifying strange creatures.

Whether you want to be an anthropologist, zoologist, astronaut, or chemist where you will be analyzing the old or deciphering the new, these activities may help you sharpen your eyes to subtle difference and help you organize data.

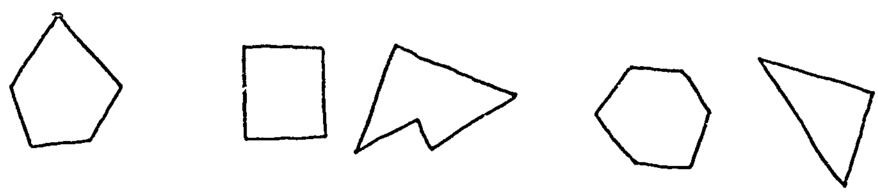
Use the clues given to pick out the distinguishing characteristics of each type of creature. Some have only one distinguishing characteristic, some have two and a few have three.

When you have finished, try making up some of your own to try on your friends.

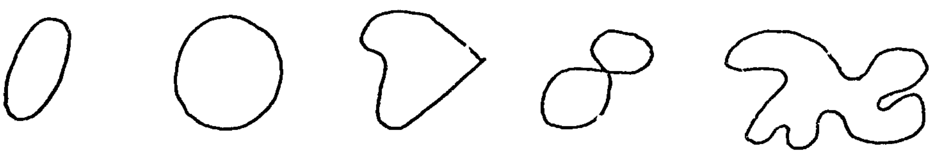
Can you think of earthly applications which might arise in the above occupations or your life?

a. Pre flight training card.

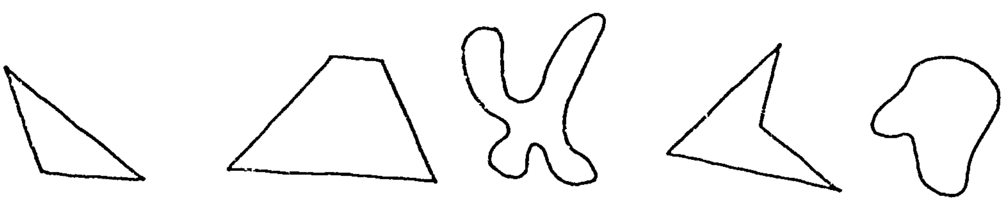
These are POLYGONS:



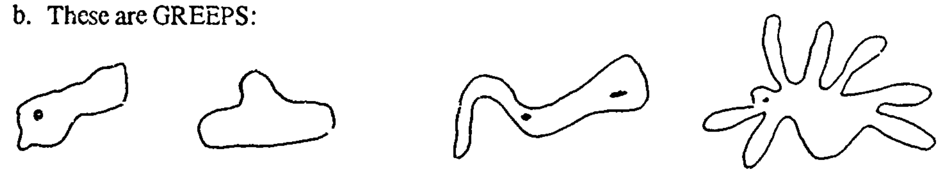
These are not POLYGONS:



Which of these are POLYGONS?

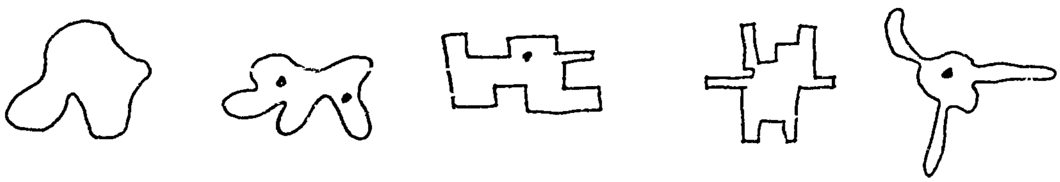


b. These are GREEPS:



These are not GREEPS:

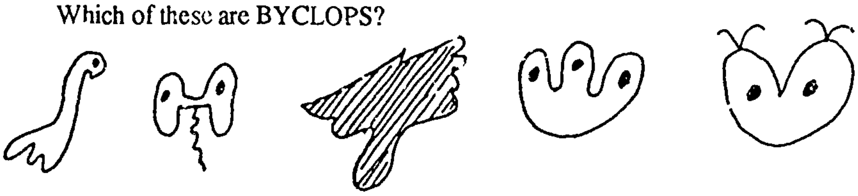
Which of these are GREEPS?



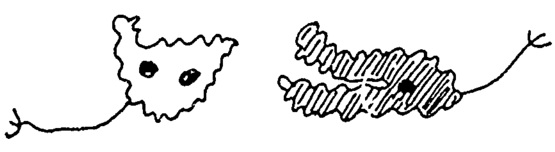
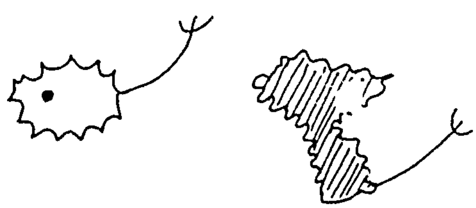
c. These are BYCLOPS:

These are not BYCLOPS:

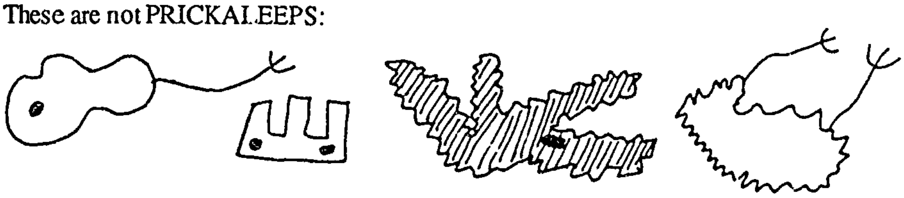
Which of these are BYCLOPS?



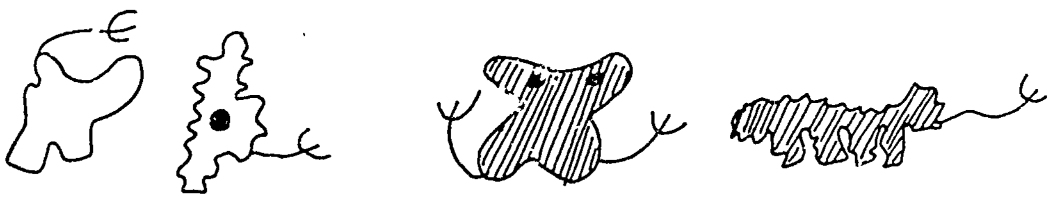
d. These are PRICKALEEPS:

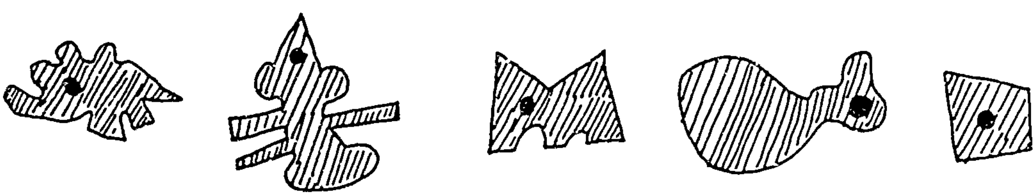
These are not PRICKALEEPS:



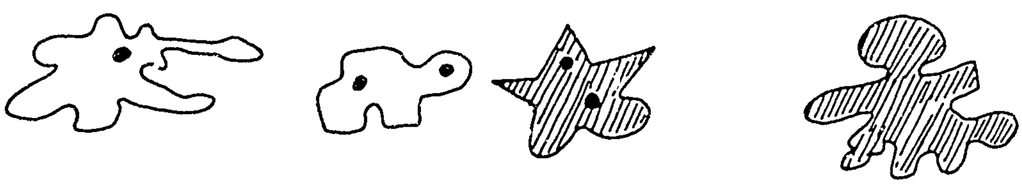
Which of these are PRICKALEEPS?



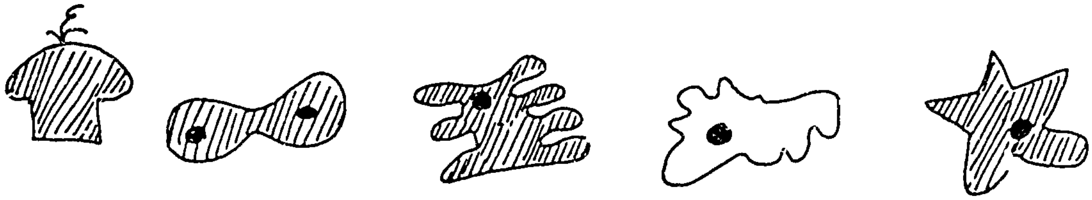
e. These are CLIPPAWAS:



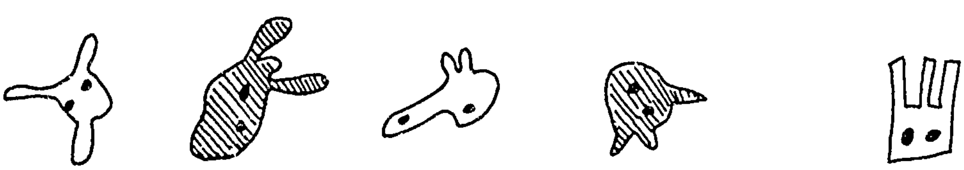
These are not CLIPPAWAS:



Which of these are CLIPPAWAS?

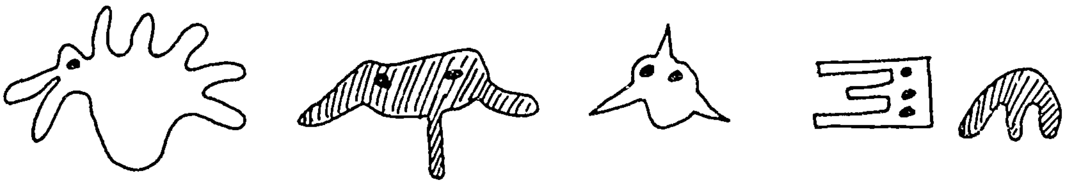


f. These are GLIFFAHUMPHS:

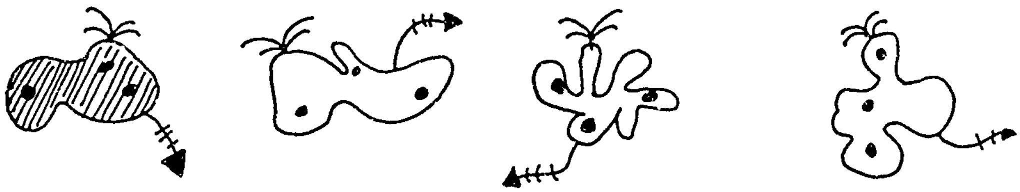


These are not GLIFFAHUMPHS:

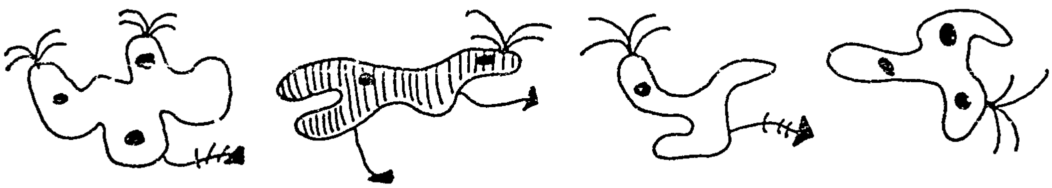
Which of these are GLIFFAHUMPHS?



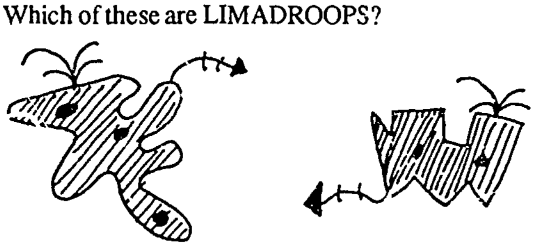
g. These are LIMADROOPS:

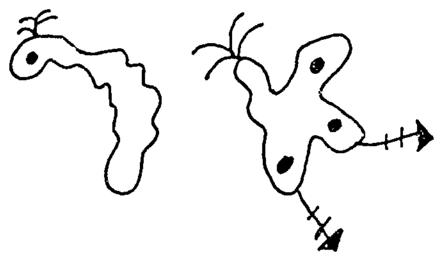


These are not LIMADROOPS:

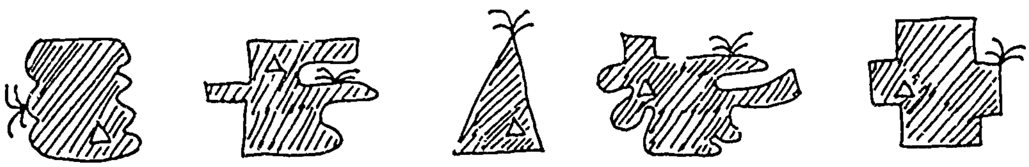


Which of these are LIMADROOPS?

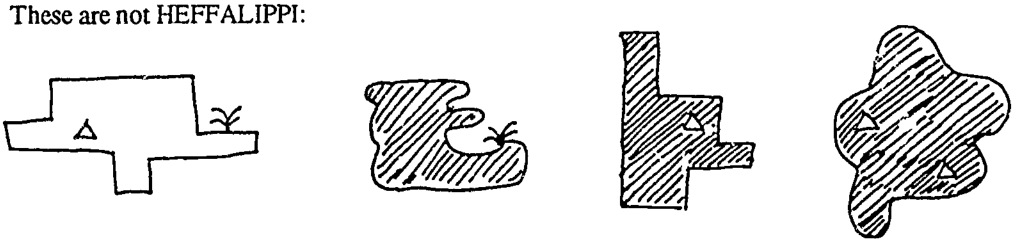




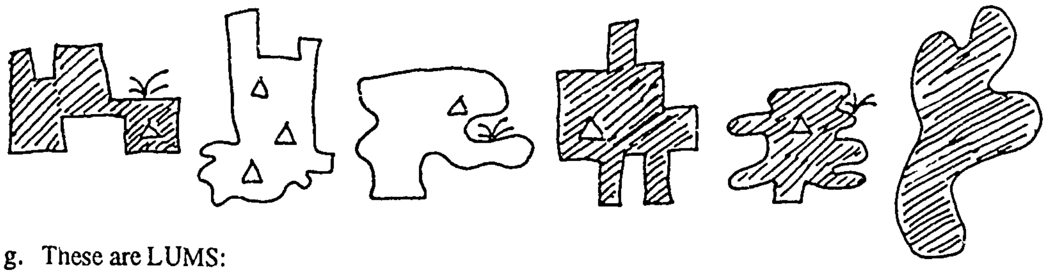
g. These are HEFFALIPPI:



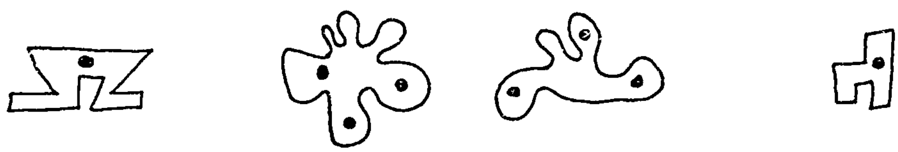
These are not HEFFALIPPI:



Which of these are HEFFALIPPI?

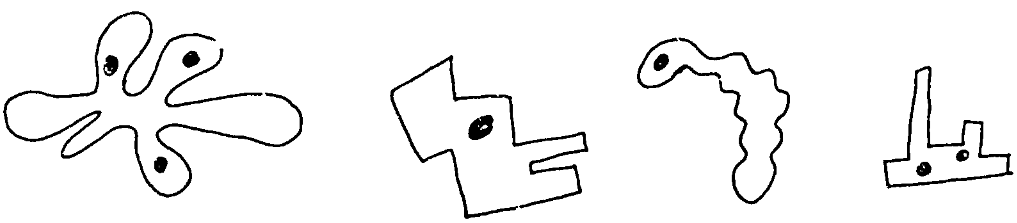


g. These are LUMS:



These are not LUMS:

Which of these are LUMS?



Activity

Toothpick Geometry

Objective

To allow students to determine the number of patterns formed by connecting two, three, four, and five points

Grade Level

Grades 6–9

Math Concept/Skills

Geometry, spatial visualization

Time

20–30 minutes

Materials

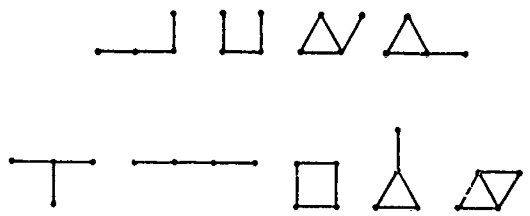
Toothpicks and "Toothpick Geometry" worksheet on the following page

Procedure

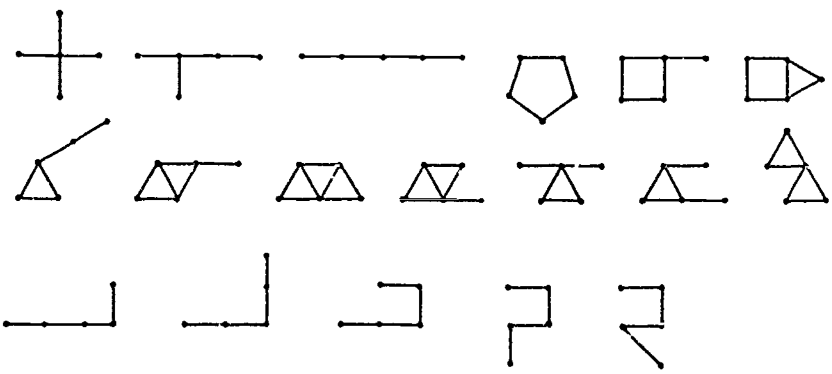
Use toothpicks to represent congruent (or equal length) line segments, and think of the ends of each toothpick as "points." How many ways can you connect a specific number of points with equal length line segments? Rotations do not count as a new pattern. For example, illustrate how *two* points can be connected in only one way: and *three* points can be connected in several ways for example: or . Note that is the same shape as , only rotated, so the latter is *not* a new pattern.

Give each student a copy of the "Toothpick Geometry" worksheet and some toothpicks. The students' task is to manipulate the toothpicks to determine the number of patterns that can be formed by connecting four or five points. Each time a pattern has been determined, it should be sketched on the worksheet. The toothpicks also work well on the overhead to display the patterns created.

Some 4 point solutions:



Some 5 point solutions:



Worksheet

Toothpick Geometry

How many ways can you connect points with equal length line segments?

2 points:

3 points:

4 points:

5 points:

Activity

Checkerboard Mania and Other Puzzles

Objective To allow students to practice spatial visualization skills

Grade Level Grades 6–9

Math Concepts/Skills Spatial visualization

Time 10 minutes for puzzle 1, 5 minutes or less for puzzles 2 and 3

Materials Puzzles below and diagrams on the following page

Procedure Duplicate the diagrams on the following page, and follow the instructions in each puzzle to perform the activity.

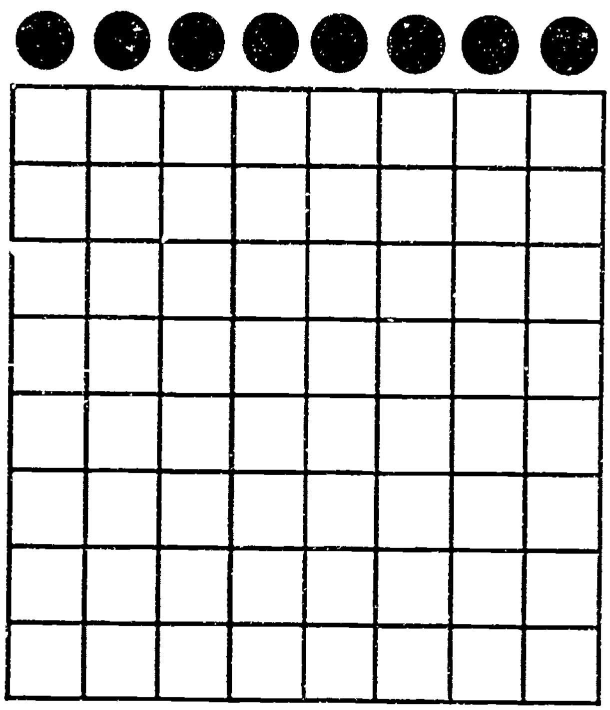
Puzzle 1. The students' task is to put the eight checkers on the board each in a different square so that

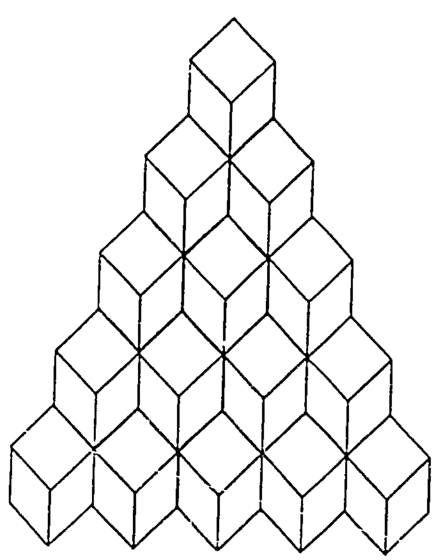
1. No two checkers are in the same horizontal row.
2. No two checkers are in the same vertical row.
3. No two checkers are on the same diagonal line.

   (One solution: Place a checker in row 1, column 5; row 2, column 2; row 3, column 4; row 4, column 6; row 5, column 8; row 6, column 3; row 7, column 1; and row 8, column 7.)

Puzzle 2. How many squares are there in the checkerboard? (Answer = 204 [Don't forget the larger squares made by combing small squares!])

Puzzle 3. The drawing on the following page represents a stack of cubes; how many cubes are there in the stack? (Hint: Make sure you count the cubes that are not visible.) (Answer = 35)





Activity

Finding the Area of a Tree

Objective

To allow students to visualize and construct a tree, given a series of shapes; to calculate the area of the tree using formulas for the areas of triangles, squares, and parallelograms

Grade Level

Grades 6–9

Math Concepts/Skills

Geometry, spatial visualization

Time

30–40 minutes

Materials

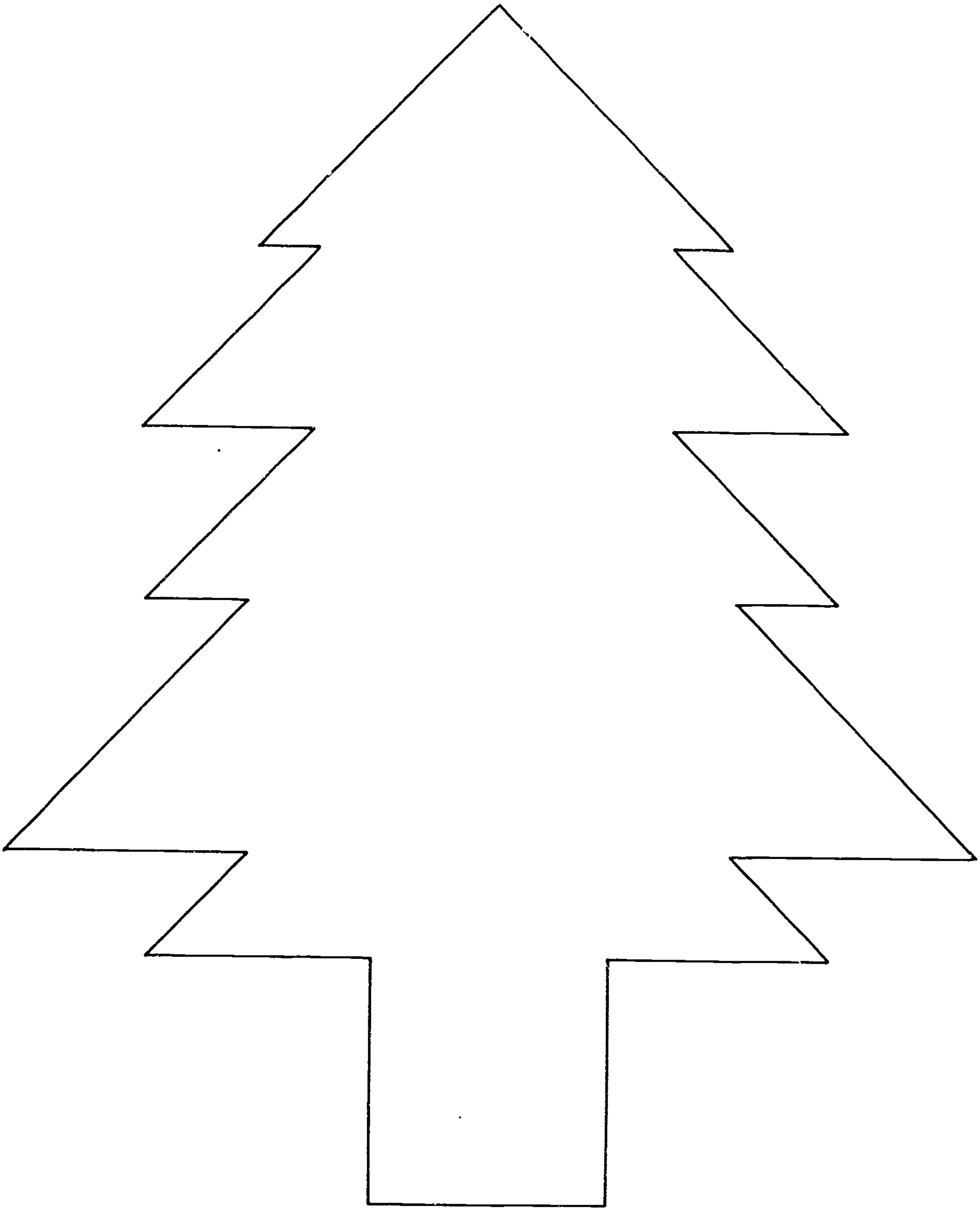
Tree shapes and tangram pieces on the following pages, paper and pencil

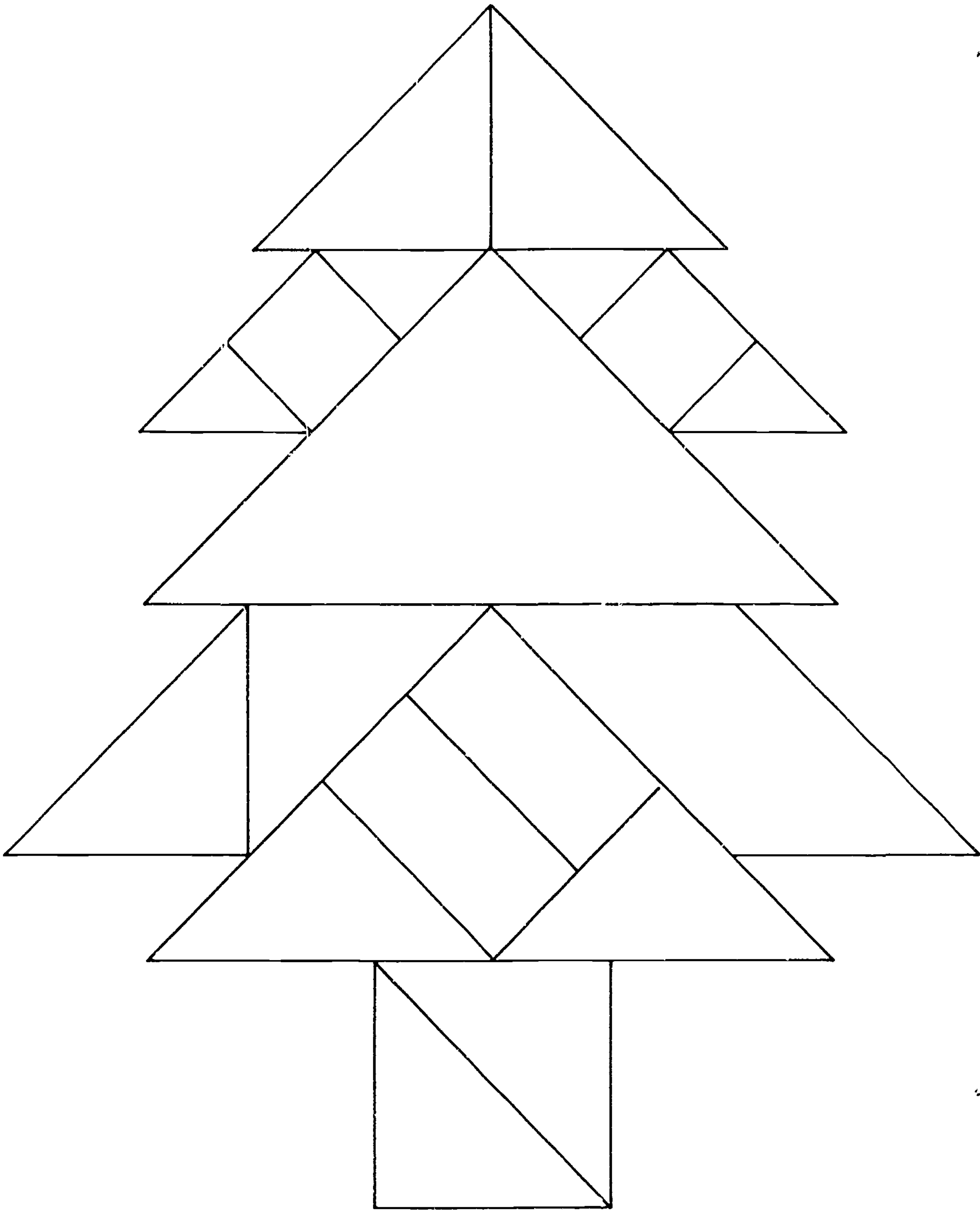
Procedure

Make and distribute one copy of the blank tree shape and tangram pieces to each student. Give the following directions:

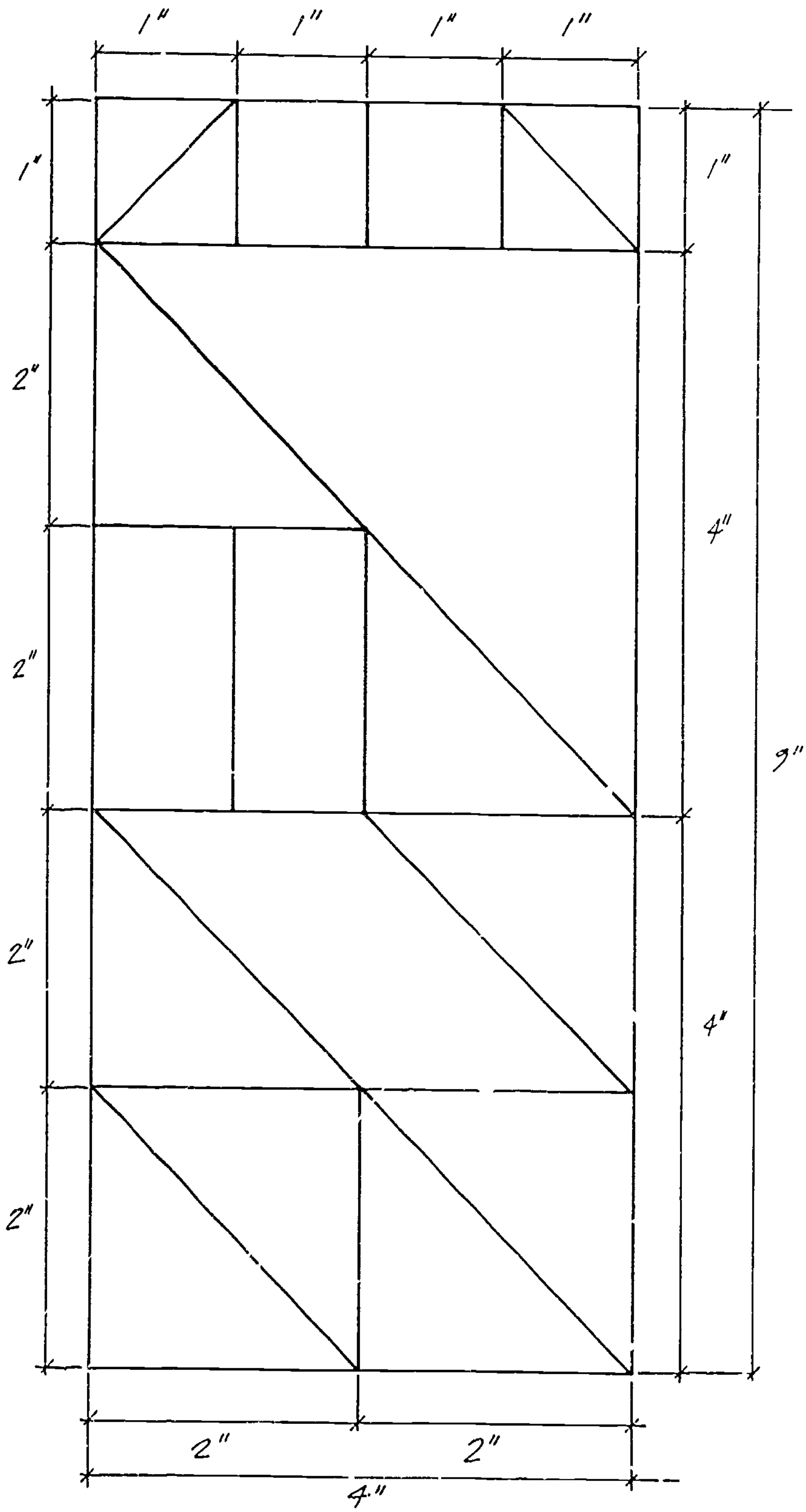
> Cut apart the tangram pieces. Use tangram pieces to fill in the tree shape. Using area formulas for a triangle ($A = 1/2bh$), square ($A = s^2$), and parallelogram ($A = bh$) find the area of the tree. (Answer = 36 sq. in.)

If students find the activity too difficult to do, hand out a copy of the tangram solution to each.





Tangram Pieces



Activity

Locate the Shapes

Objective To locate geometric shapes on a four-quadrant grid

Grade Level Grades 6–9

Math Concepts/Skills Geometry, spatial visualization

Time 10–15 minutes per game

Materials Copies of the grid and shapes on the following pages

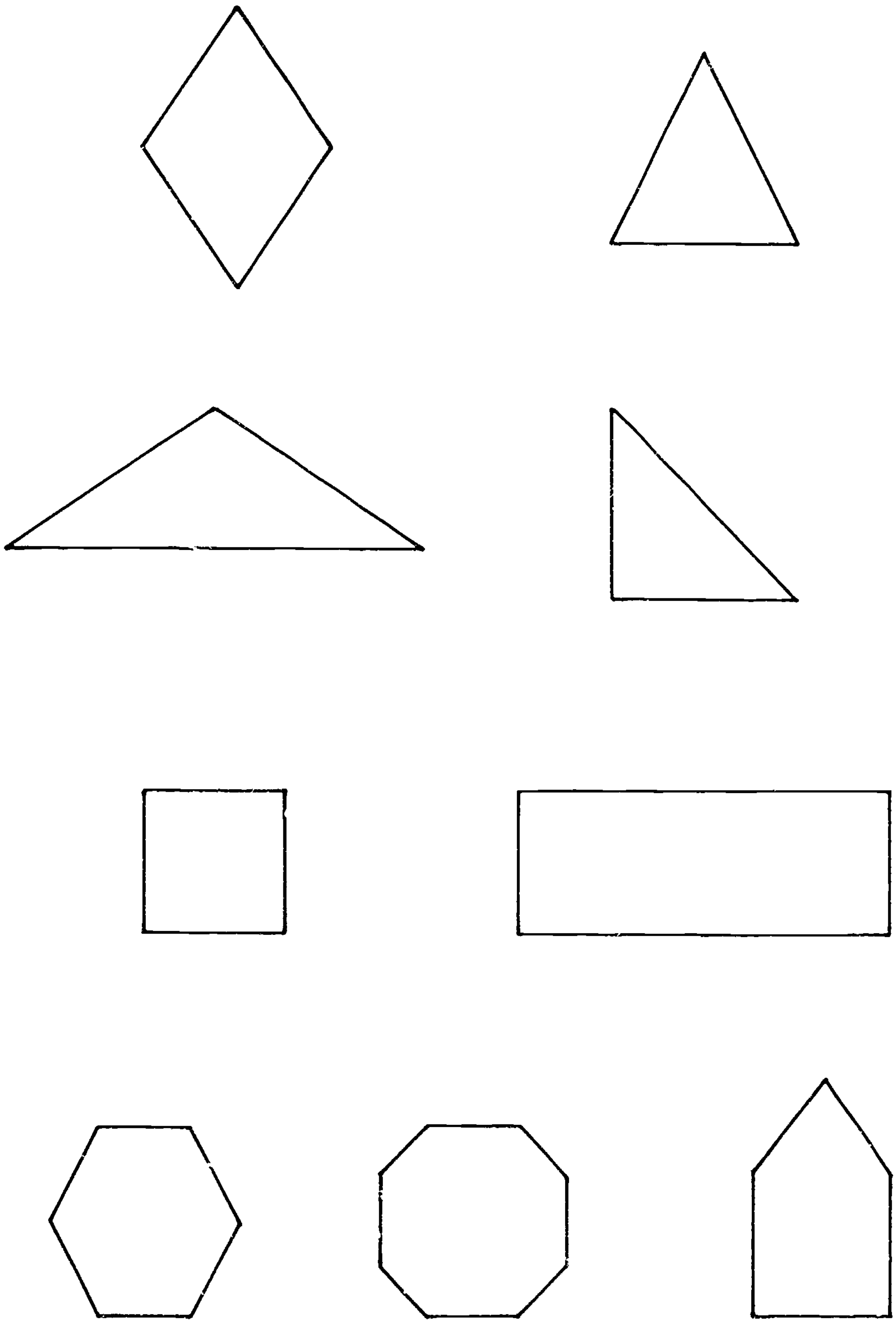
Procedure Duplicate the geometric shapes on the following page. Give each student *one* set of shapes and *two* sheets of grid paper. Let each student play the game with a partner. Have students cut out their shapes. Each student places any three of the shapes on a sheet of grid paper. Each student shape must be placed so that its horizontal and vertical edges lie on a horizontal and vertical line on the grid, and its vertices lie on an intersection of a horizontal and vertical line on the grid.

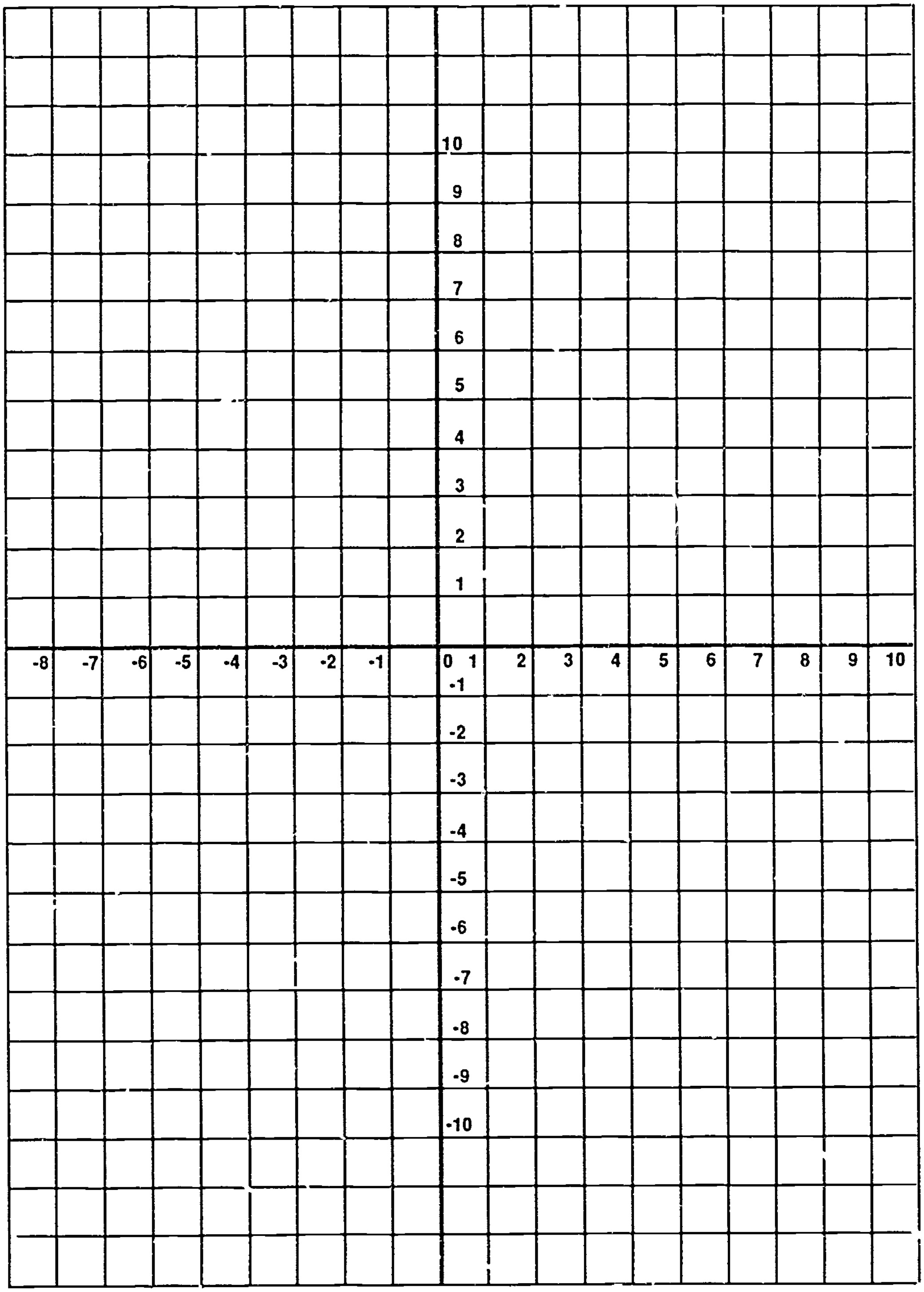
Players flip a coin to determine who starts the game. Each player names one set of coordinates during each turn. A player names the coordinates by giving the x coordinate first and the y coordinate second, such as 6, 4 or 7, -2. His/her partner answers "on" if the edges of a shape coincide with that coordinate, "in" if that coordinate is inside the shape, or "out" if the coordinate is outside the shape.

The goal of the game is for each player to locate and identify all of his/her partner's shapes by naming the shape and the coordinates of three consecutive vertices. The first player to locate all three shapes wins. The game may then be played again, with players selecting and placing a new set of three shapes on their grids.

Players should use their second sheet of graph paper to keep track of the coordinates they have named and whether each coordinate is in, on, or out, to help them determine the type and location of each shape.

Variation Students could also determine area and perimeter of the pieces. A variation of the game would be to use only pieces with set perimeters, for example, between 5 and 10 units.




10
9
8
7
6
5
4
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1
-8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10

Resources

Blackwell, P. J. 1982. *Spatial encounters: Exercises in spatial awareness.* Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

A fun book for students of all ages who need to develop their spatial visualization skills. *Spatial encounters* contains a variety of games and exercises that involve figure completion, memory of shapes, and rotation. The book is particularly helpful for girls whose skills have been hampered by lack of practice.

Burger, W. F. 1985. "Geometry." *Arithmetic Teacher* 32, no. 6: 52–56.

This article describes common misconceptions students hold about shapes and suggests a number of activities to introduce elementary and middle school students to informal geometry and strengthen their skills in analyzing and classifying shapes by their properties. The article contains an excellent bibliography of materials and activities useful in teaching informal geometry.

Burger, W. F., and Shaughnessy, J. M. 1986. "Characterizing the van Hiele levels of development in geometry." *Journal for Research in Mathematics Education* 17, no. 1: 31–48.

In this article, eight tasks that can be used to determine students' levels of development in geometry are described. Theses activities can also be used to teach basic geometric concepts.

Crowley, M. L. 1987. "The van Hiele model for the development of geometric thought." In *Learning and teaching geometry, K-12,* edited by M. M. Lindquist, 8–12. Reston, VA: National Council of Teachers of Mathematics.

Manipulatives are used to help students understand geometric concepts in the many activities suggested in this article.

Downie, D.; Slesnick, T.; and Stenmark, J. K. 1981. *Math for girls and other problem solvers.* Berkeley: University of California, Math/Science Network.

The activities in this book encourage independent thinking and creativity in mathematics. Students and teachers are encouraged to think about problem solving in versatile ways and forms. Although this book was originally designed for females, the activities are appropriate and interesting for both boys and girls ages 7–14. The book would also be an excellent resource for math clubs.

Fraser, S., ed. 1982. *SPACES: Solving problems of access to careers in engineering and science.* Berkeley: University of California, Lawrence Hall of Science.

A collection of thirty-two classroom activities designed to stimulate students' thinking about math-related careers, develop problem-solving skills, and promote positive attitudes toward math. Activities are designed for students in grades 4–10.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics and provide information about opportunities for women in nontraditional careers. The purpose of the program is ultimately to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes sections with activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction.

Kespohl, R. C. 1979. *Geometry problems my students have written.* Reston, VA: The National Council of Teachers of Mathematics.

As the title implies, the everday problems in this book were written by high school students. Interesting problems were designed to teach skills in geometric construction, procedures, formulas, and concepts. The book also includes brief sections on arithmetic, algebra, and trigonometry. Many of the problems are suitable for junior high students.

Prevost, F. J. 1985. "Geometry in the junior high school." *Mathematics Teacher* 78, no. 9: 411–18.

This article includes paper folding, arranging, and cutting exercises that teach students the properties of shapes and the relationships among shapes.

Silvey, L., and Smart, J. R., eds. 1982. *Mathematics for the middle grades (5–9).* Reston, VA: National Council of Teachers of Mathematics.

This book was developed to aid teachers in promoting the mathematical development of students in grades 5–9. The three sections of the book cover critical issues in mathematics education, unique learning activities, and strategies for teaching problem solving.

Skolnick, J.; Langbort, C.; and Day, L. 1982. *How to encourage girls in math and science. Strategies for parents and educators.* Palo Alto, CA: Dale Seymour Publications.

This excellent resource examines the effect of sex-role socialization on girls' math/science skills and confidence. It explains how attitudes, parenting and teaching practices, stereotypical play activities and books, peer pressure, and career and family expectations cause girls to question their abilities in math and science, and thus hinder their development in these areas.

In addition to a summary of the socialization process, this book contains a variety of compensatory educational strategies and activities that may be used to encourage females in mathematics. These particularly focus on increasing math confidence, spatial visualization skills, and problem solving and are designed for primary through junior high school students. Both parents and educators can benefit from this book.

Stenmark, J. K.; Thompson, V.; and Cossey, R. 1986. *Family math.* Berkeley: University of California, Lawrence Hall of Science.

If mathematics promotion is a goal of your teaching, *Family math* activities will help you introduce parents and children to ideas that improve their math skills and help them gain an appreciation for math. Topics are geared to the K–8 math curriculum. Hands-on mathematical experiences provide families an opportunity to develop problem-solving skills by looking for patterns, drawing pictures, working backwards, working cooperatively with a partner, and eliminating possibilities. The mathematical concepts learned from *Family math* are spatial relationships (geometry), estimation, data interpretation (probability and statistics), and mathematical reasoning.

Improving Test-Taking Skills

Although girls generally do as well as boys on tests that cover materials learned in the classroom, their performance tends to be poorer than that of boys on standardized tests, such as the Scholastic Aptitude Test (SAT) or the American College Testing Program (ACT). Many educators prefer to deemphasize the use of standardized tests; however, in today's educational climate, these tests can have a great impact on students' futures. In some school systems, students are tracked based on scores from standardized test, such as the California Achievement Test (CAT). Test scores also impact students' placement in advanced or enriched programs, entrance to particular colleges, and awards of scholarships or other forms of financial aid for postsecondary school. Thus, even as we work toward a better way of assessing student achievement, we still need to ensure that students know how to do as well as they can on standardized tests. There are some indications from research that girls may be attending to different cues and taking in too much distracting information. Others hypothesize that boys may do better because they are more competitive and may be less anxious about performing under pressure.

- In results of recent national testing of high school students, boys out-scored girls on the mathematics portion of the SAT by 47 points, which represents an average score that was 10.4 percent higher for boys than for girls. On the ACT mathematics subtest, boys' average scores were 15.5 percent higher than the average scores for girls. ("Gaps persist between sexes" 1987)

- Even when the SAT is given to seventh graders, there is a large difference (35 points) favoring boys; this difference cannot be explained by differences in course-taking at school. (Fox 1981)

- Some researchers have suggested that sex differences in math scores may be due to content bias in the tests; others suggest that girls use a poorer test-taking strategy than boys use. (Dwyer 1987)

- Testing often represents a pressure-filled situation for students. Increased evaluative pressure has been found to enhance the performance of boys, but to impair the performance of girls. (Dweck and Gilliard, cited in Russo 1985)

- Slightly speeded tests that feature easy to hard item order favor male students more so than any other item arrangement. In one study, girls performed best when items were arranged in many small clusters of easy-to-hard order. (Plake et al. 1982)

- Female students generally experience significantly more test anxiety, as measured by the Mathematics Anxiety Rating Scale, than do boys. (Plake et al. 1982)

The following suggestions should help all students improve their test-taking skills and should provide practice that will build a foundation to assist girls in scoring better on national tests.

Strategies

1. *Vary* the format of tests; give objective math tests.

    a. Design a test supplying all the answers. Students need to work the problems to eliminate the incorrect answers.

    b. Design a matching test.

    c. Design a multiple choice test. Include choices of "not here" or "none of the above" if you want to prevent guessing.

    d. Design an oral math test. This can be dictated onto a tape for presentation to the class.

2. Let parents know from the beginning of the year how their son or daughter can get the most out of your math class (see the parental involvement section). Send home information about your grading procedures and how or when you schedule tests or other assessments.

3. Provide frequent, mixed, cumulative review. Have an ongoing maintenance program for previously learned topics.

4. Cover key topics before test-taking time.

5. There is usually more than one right way to do a math problem, so accept a student's alternative procedure if it and the solution are correct.

6. Encourage students to take time to work problems out with paper and pencil, but teach them techniques and concepts that will help them work faster. Teach students to recognize patterns and use estimating to check their answers.

7. Don't always push for speed in solving math problems. Quickness doesn't ensure correctness. Also, don't insist on super neatness, but do insist on clarity and legibility. Don't require students to copy work from scratch paper onto a test, just to make the paper neat.

8. Determine how many problems you *really* need on a test to test what you want to know.

9. Teach students the skills involved in test taking—examining problems for key words, using a process of elimination, etc.

10. To help students learn to solve word problems, (a) have them rewrite problems and (b) let them write their own problems for other students to solve.

11. Let students make up their own tests along with the answers. Constructing test items helps students think through the steps involved in solving problems.

12. In preparing students for standardized tests, use the following strategies:

    a. Know the territory. Take important format features of the test and devise ways to incorporate them into your teacher-made tests.

    b. Go slow on the easy questions. Don't speed through easy questions to save time for the hard ones. The easy questions often help students focus on solution processes.

    c. Practice. Be sure students have the basic skills required on the test and also that they understand and have practiced with the test's instructions and answering format.

    d. Let students feel you're confident that they'll do well.*

13. When a standardized test contains a series of questions based on a graph or chart, students often spend too much time studying the material and may be overwhelmed by superfluous information. Tell students to first skim the graph for general content, then read the questions, then go back to the graph and look for the answers. Incorporate these types of problems in your tests to give students practice.

14. Sometimes word problems contain spelled-out numbers or values such as dozen. Students often focus only on the numerals and overlook these written-out numbers. To help them avoid these types of errors on standardized tests, provide practice word problems that feature a combination of numerals and written values.

15. The book *Assessment alternatives in mathematics: An overview of assessment techniques that promote learning* by Stenmark (see resource list) provides excellent ideas to help you develop student assessments that pinpoint students' real math achievement and highlight areas where students' understanding is incomplete.

* Item 12 is from "Make your students test savvy" by W. Kroen, in *Instructor* 96, no. 7: 66.

Activity

Practice Test

Objective To familiarize students with the testing format and practice skills required for a specific test

Grade Level Grades 6–9

Time 30–45 minutes for preparation, approximately 30 minutes for the activity

Materials Practice test

Procedure This activity requires extra time from teachers, but definitely helps students study for a standardized test. Using the test format and type of problem(s) to be tested, select two sample problems (similar to but not actual test questions) from each area. Design a practice test following the exact format of the standardized test. After the practice test, it is crucial that the answers (for concept understanding) and test format (for test-taking skills) be thoroughly reviewed with students.

Activity

"Test-Wiseness" and Study Skills Training

Objective

To teach students how to study for and score well on standardized tests

Grade Level

Grades 6–9

Time

20 minutes per session

Materials

Copies of "Hints to Make You 'Test-Wise,'" "Checklist of Test-Taking Techniques," and "Study Skills and Strategies" handouts on the following pages

Procedure

Test-wiseness has been defined as the capacity to use the characteristics and formats of the test and/or test-taking situation to recieve high scores—independent of knowledge about the subject matter of the test. In other words, a test-wise person can increase her or his test scores by using strategies and attending to cues that have little to do with the test content. The results of many studies have shown that test-wiseness can be learned, that training is not effective until students reach at least the fourth grade, and that 9–14 hours of training are best for maximum results.

Four skills have been found to produce significant improvement in students' standardized test performance. These skills are following directions, using time wisely, guessing strategies, and answer changing. In addition, multiple choice questions allow the test-wise student to eliminate distractors by attending to cues unrelated to test content.

On the following page, some test-wiseness hints are listed that are partially based on material from a 1986 article by Benson et al. (see resource list).

Before using these hints, make sure that they are appropriate for the standardized tests you give; modify them if necessary. For example, the hint "Do not leave any question blank," as well as all of the guessing hints, is only a good strategy if there is no penalty or correction for guessing.

Go through the hints with students, helping them with examples from a previous math test. Have students practice only one strategy at a time

Included as part of this activity are a "Checklist of Test-Taking Techniques" and a list of "Study Skills and Strategies" to help students prepare for tests.

For a copy of a test-wiseness curriculum manual covering the four strategies, write to Dr. Jeri Benson, Department of Measurement, Statistics, and Evaluation, University of Maryland, College Park, Maryland 20742.

Handout

Hints to Make You "Test-Wise"

Following Directions

1. Read and listen carefully to directions before starting the test.
2. If you don't understand something about the test or how to fill it out, ask the test administrator before starting the test.
3. Fill in only one answer for each question on the answer sheet.
4. Fill in the answer space completely.

Using Time Wisely

1. Know how much time you have to take the test.
2. Pace yourself so you have enough time for each question, but use all of the allotted time.
3. Answer all the questions you know first, and go back to the harder questions later.
4. Do not leave any question blank, unless there is a penalty for guessing.

Guessing

When there is no penalty for guessing:

1. Make your best guess instead of leaving a question blank.
2. When guessing, reread the questions carefully.
3. When guessing, read every option carefully.
4. Guess only after going through these steps.

When there is a penalty for guessing:

1. Don't guess unless you have some rationale for your guess and can eliminate one or more alternatives.

Changing Answers

1. Change an answer when you know you marked it wrong.
2. Change an answer when another seems better.

Handout

Checklist of Test-Taking Techniques

1. When it is possible to prepare for a test, do so.
2. Know in advance if the test has a correction formula or a penalty for guessing.
3. Eliminate alternatives on a multiple choice test.
    a. The "always" and "never" alternatives are often incorrect.
    b. Eliminate alternatives that don't fit the stem.
    c. Eliminate absurd alternatives.
    d. If two alternatives are the same, they are probably incorrect.
    e. If you have to guess, when choices range in value, reject the extreme values and select a middle range alternative.
4. Read directions *carefully*.
5. If part of a statement is given and you are asked to choose the second part, attempt to answer the question before you read the choices.
6. Read the questions carefully.
7. If the test requires you to read long passages and then answer questions, read the questions first, so you know what to concentrate on when reading the passage.
8. Answer the easy questions first. Skip items you are unsure of, and go back to them later. When the answer comes to you, go back and mark it.
9. Go ahead and change your answer if another seems more appropriate.
10. If you have time, recheck and correct your work before turning the test in.
11. Review your test after it has been corrected.
12. On true/false questions, select "false" unless the answer is entirely true.
13. Never leave a multiple choice question unanswered, unless you are unable to eliminate a single choice.
14. On a math test, if the answers are multiple choice, look at the options before you work the problem. Sometimes, it makes more sense to just try the answers in the problem than to work out the problem. Decide whether you need to work out the problem or try the answers in the problem.

15. When working problems, write your work clearly so you can more easily find and correct mistakes.

16. Leave lots of space to make corrections.

17. When working word problems draw a picture diagram.

18. If you've seen a similar problem before, think about how you solved that problem and try the same technique with this problem.

19. On difficult problems, try substituting smaller numbers to see how to solve it.

20. On difficult problems, try working backwards.

21. On difficult problems, try "playing" with the numbers.

Handout

Study Skills and Strategies

1. Organize a place to study.
2. Organize your study time.
3. Organize your study activity.
4. Start preparing for an exam early.
5. Review step-by-step.
6. Practice using the skills needed to solve the problems on the test.
7. Make up practice problems from your textbook that require the same skills that will be tested.
8. Study where it's slightly cool, not warm and cozy.
9. Use 3" x 5" flash cards to check your memory of basic facts or formulas.
10. Have a fixed time set aside for study each day. Use that time whether you have homework or not.
11. Misery loves company. Recent studies show that students who study with others get emotional support.
12. Use a tape recorder if you have to memorize.
13. Get involved in class discussions, and ask questions when you don't understand.
14. Pay attention in class.
15. Don't study when you're sleepy.
16. After a test, be sure to go over it after it has been corrected and make sure you can answer any questions you missed.

Activity

Math Bowl

Objective	To review skills to be tested
Grade Level	Grades 6–9
Time	20 minutes for preparation, plus 20–30 minutes for the activity
Materials	3" x 5" cards
Procedure	Depending on the type of test—cumulative, standardized, criterion-referenced, teacher-prepared, chapter test, and so on—select sample problems. Put each problem on a 3" x 5" card with the solution. Divide the class into equal number teams. Problems can be given individually (as in a spelling bee) until all members of a team have been eliminated or given in a cooperative manner in which the team decides on the solution. This activity can easily be adapted to all levels of math, requires little work of teachers, and encourages students to review on school time, not their time!

Activity

Math Words

Objective To write steps and solutions to problems for test review

Grade Level Grades 6–9

Time Variable—20–30 minutes

Materials Problems from textbook

Procedure Give each student a different set of problems from a specific page in the text. Instruct a student to fold a piece of paper in half (lengthwise). On the left side, the student works each problem; on the right side, he or she explains, in words, how to solve the problem.

Use this activity with individual students as a check for understanding or in a partner situation to help students who are having difficulty. This technique is especially effective in solving word problems, but is also helpful in breaking down understanding of the multiple steps required in computational math problems.

Resources

Benson, J.; Urman, H.; and Hocevar, D. 1986. "Effects of test-wiseness training and ethnicity on achievement of third- and fifth-grade students." *Measurement and Evaluation in Counseling and Development* 18, no. 4: 154–62.

This article summarizes findings from a study on math achievement after test-wiseness training. The study includes information from a test-wiseness training manual and lists a number of strategies for students.

Garcia-Barrio, C. 1984. "Ace it: How to get through finals with flying colors." *Essence* 15, no. 8: 24.

This brief article includes a list of study and test-taking strategies.

Grassick, P. 1983. *Making the grade: How to score higher on all scholastic tests.* New York: Arco Publishing.

Includes a number of tips and strategies for test-taking.

Kroen, W. 1987. "Make your students test savvy." *Instructor* 96, no. 7: 66.

A brief article that provides several suggestions to help students become test-wise.

Margenau, J., and Sentlowitz, M. 1977. *How to study mathematics.* Reston, VA: National Council of Teachers of Mathematics.

A study guide written to give math students suggestions or prescriptions for problems in study and test-taking skills. The guide is illustrated with cartoons to appeal to the junior high or high school student.

Stenmark, J. 1989. *Assessment alternatives in mathematics: An overview of assessment techniques that promote learning.* Berkeley: EQUALS, Lawrence Hall of Science.

This book is an excellent resource for exploring ways to assess students' progress other than through standardized multiple-choice tests. The book makes a strong case against the use of standardized tests and reporting students' progress through grades. Instead, the author suggests using assessment methods that promote student learning, assess real mathematics achievement and understanding, and match your goals for each students' progress. Alternative assessment methods described in the book include evaluating students' completed tasks or products (portfolios, writing, investigations, and open-ended questions) and students' performance through observation, interviews, and questions. The book also discusses self-assessment, provides sample assessment problems, and includes a good list of references on alternative assessment methods.

Part 5

Mathematics Promotion

This section of the guide contains ideas to help you promote mathematics as an important and worthwhile subject. It includes suggestions for

1. involving parents
2. working with counselors
3. working with administrators and other teachers to promote math throughout your school

Increasing Parent Involvement

Parents' attitudes and expectations for their children are probably the most important factors in determining students' own attitudes, expectations, mathematics participation, and achievement levels. We know that many parents treat boys and girls differently. We also know that it can be extremely difficult to involve some parents in their children's education.

- Parental attitudes are crucial in determining a young woman's self-concept regarding her abilities, interests, and career goals. (Becker 1984; Wigfield 1983; Fox 1982)

- Girls respond more than boys to parental expectations. (Burton et al. 1985)

- Parents consider mathematics to be more important (Eccles [Parsons] et al. 1985) and more appropriate (Fox 1977) for boys than for girls; they believe math is more difficult for girls than for boys and that girls have to work harder than boys in order to do well in math courses. (Eccles [Parsons] et al., cited in Stage et al. 1985)

- Parents of students who eventually took more than the required math classes in high school were perceived to have been more encouraging (Sherman et al., cited in Chipman and Wilson 1985); parental expectations and support frequently differentiate students who continue in math from those who do not. (Stallings 1985)

- Perceived parental encouragement was strongly related to twelfth-grade math achievement, but it was not a factor at age thirteen (Armstrong 1985). Sherman reported a strong relationship between parental encouragement and measures of mathematics achievement for girls, but not for boys. (Cited in Chipman and Wilson 1985)

- Support and encouragement from parents was a crucial factor in students' decisions to elect mathematics courses in high school; for girls, the influence of their fathers was greater than that of their mothers. Parents were found to have lower expectations for girls than for boys and to foster mathematical self-confidence and course-taking less for girls than for boys. (Fox 1981)

The strategies described on the following pages are designed to assist you in involving parents in their children's math education. Information to help modify some parental attitudes toward girls and math is also included.

Strategies

1. As much as possible, try to communicate directly with parents about their children's accomplishments, as well as problems. Use one or more of the activities on the following pages to initiate contact with parents. Some teachers contact parents only when there is a problem. When parents understand that you are genuinely interested, they will become more involved with their children's math education.

2. Use every opportunity—letters, newsletters, phone calls, parent conference, and school visits—to educate parents about the importance of positive math attitudes and the encouragement of their children.

3. If your school sends a newsletter to parents, write a brief column to educate parents about math attitudes, and give them ideas for working with their children in mathematics. If there is no newsletter for parents, suggest one to your principal. Another alternative is to get together with other teachers and produce a flier for parents—each issue can emphasize a different subject.

4. To encourage parents to join their children in interesting and fun math activities, occasionally send home math puzzles and teasers. Some excellent sources for these are the books *Math for smarty pants* and *The I hate mathematics book* both by Burns, *Games and puzzles for elementary and middle school mathematics: Readings from the Arithmetic Teacher* by Smith et al. (see resource list), and individual copies of the *Arithmetic Teacher* magazine. Check the resource list from the section on problem solving for other sources. Parents and students can work cooperatively on these activities.

5. Another idea for using puzzles, games, and teasers is to go over the explanation in class, then have students teach their parents how to solve these mathematical puzzles. Obtain parental cooperation before beginning the activity. The idea is to encourage the student to master concepts by teaching them and to let parents observe their child's level of mathematical understanding.

6. Recommend the books *Family math* by Stenmark et al. and *How to encourage girls in math and science* by Skolnick et al. to parents (see resource list). These paperbound books are filled with interesting math activities designed for parents and children. *How to Encourage Girls in Math and Science* (chapter 3—"Adolescence and Beyond") also contains an excellent discussion of the conflicts adolescent girls face in deciding about their futures. The material would be very helpful for counselors, teachers, and parents.

7. If some parents are interested, but don't know how to tutor their children in math, hold a math help session for parents or a series of sessions on particular math topics you'll be covering in the coming weeks.

8. Bring interested parents (especially mothers) into the classroom to help as math aides. Enlist parents to help in special after-school tutoring sessions for students needing additional assistance.

9. Hold special "math fun" or "math extravaganza" sessions for parents and students. Allow for the single parent or the child whose parents are unavailable but who could bring an older sibling, another relative, or other adult. (See *Family math* by Stenmark et al. for additional information on planning and conducting these sessions. This book is listed in the resource list.)

10. Hold a math careers night (or weekend workshop) for parents. Obviously, a student in the junior high years is not ready to make definite plans for a future career; however, it is helpful to encourage parents to begin thinking about their children's options and about the need for math. It is particularly important that parents understand that their daughters definitely need to have a sound math background. To put together a career workshop, you might work with your school counselor. Also, consult the resource list in the "Math Relevance" section of this guide for sources of information on math-related careers. The posters *When are we ever gonna have to use this?* by Saunders and *Dropping math? Say goodbye to 82 jobs* by Wiggan (see resource list in the following section on working with counselors) contain helpful information on this topic.

Activity

Letter to Parents

Objective	To establish communication with the parents of your student to gain the support ot parents by informing them of your expectations for their child
Grade Level	Grades 6–9
Time	30 minutes
Materials	A sample letter to parents
Procedure	Develop a letter that briefly introduces you and your philosophy, informs parent about your mathematics classroom requirements, invites their involvement, and lets them know when you are available for conferences. A sample letter is presented on the following page; you can modify it to fit your needs. If you have access to a word processor, you may prefer to address each letter personally and refer to the student by name. Send a copy of the letter home with each student early in the school year, so that you gain the support of parents at the beginning of the term.
Variation	Send a series of letters throughout the year describing the student's progress and/ or giving parents more specific suggestions for involving their child in math, providing encouragement, do's and dont's, etc.

Handout

Sample Letter to Parents

September 19xx

Dear Parents:

I would like to introduce myself. I am___________________, your child's ______ grade teacher. (You might make a statement here about how long you've been teaching or the length of time you've taught at this school.)

Your child's success in mathematics is very important, and our communication and support can make the difference between her/his success or failure. Working as a team, we can promote healthy and positive attitudes and habits that help your child advance in math.

Below, I have listed some of the requirements of grade___ math. Also listed are some suggestions that will help your child succeed in math.

Classroom Procedure

- Homework daily—I usually require approximately ______ minutes per night.
- Tests are given frequently. Students will be informed of the test two days prior to the test date.
- Students are expected to attend class prepared with the necessary materials.

Suggestions for Helping Your Child Study Math

- Provide a special, quiet place free from distractions for study.
- If possible, provide a calculator and help your child discover the ways it can be used.
- Expect homework to be done.
- Try to keep your comments positive; give your child lots of encouragement.
- From time to time, request to see the following:
  –An assignment notebook recording daily assignments.
  –Homework assignments—you need not check the calculations; look for legible completion of the assignment.
  –Quizzes and tests.

Teacher Support

- Computer grade reports will be sent home every other week.
- Tests and quizzes will be sent home with your child.
- Extra help—I am available daily before or after school by appointment.
- I am available for parent conferences ____
  Please call the school at xxx-yyyy for an appointment.

I want to invite you to visit our classroom and to communicate with me about your child's math progress throughout the year. Thank you for your support, and I am looking forward to your child's successful year in _____ grade math.

Sincerely,

I have reviewed this letter with my child.

Parent Signature ____

Activity

Computer Gradebook for Reports to Parents

Objective

To give students and their parents updated progress reports of their grades in math

Grade Level

Grades 6–9

Time

Less than one hour to set up, 20 minutes per week to enter scores (Once set up, the benefits of this activity outweigh the initial set-up time required.)

Materials

Computer, printer, and gradebook software

Procedure

Select a gradebook software program that will run on your computer, and follow the instructions to set up printouts of student scores and grades, as well as personal messages to students or parents. For parent reports, write comments about student progress, and ask students to obtain a parent's signature. You might send these progress reports to parents two or three times during each grading period. Some teachers offer extra credit to students for parent signatures. Some suggestions for comments to parents are presented on the following pages, which include examples of printouts from the *Gradebook Plus (Pro Version)* program.

Variation

1. Reports can be personalized for students, with comments about their progress and positive suggestions for improvement. Make sure that your comments stress your belief that the student has the ability to learn math.

   The following list includes a sampling of gradebook computer programs:

   Gradebook (Plus Pro Version) (Apple II)
   E.M.A. Inc.
   P.O. Box 339
   Los Altos, CA 94023

   Apple Grade Book (Apple II)
   Gradebook Delux (Apple II)
   Gradebook Average Reporter (TRS 80) (Commodore 64/128)
   Learning Arts
   P.O. Box 179
   Wichita, KS 67021

2. Instead of reporting grades on number scores, you may want to substitute reports that describe the extent of students' concept and skill mastery. List the key concepts and skills that the class is currently working on, and rate students on their mastery of the concept, e.g., extremely competent, competent, adequate, or inadequate. You may also rate each student according to your goals for her or him, e.g., creativity in problem solving—frequently, sometimes, or seldom.

TO: ______________________ FROM: Ms. Jones

Here is a progress report on your daughter's math work. She will be given five extra credit points if this letter is returned with your signature on it by Friday.

Gina Jefferson's scores as of 04/15/90

1. Homework Sept. 15: 4/5
2. Decimals page 36: 4/5
3. Adding Decimals page 40: 3/5
4. Estimating Decimals page 44: 5/5
5. Homework Sept. 25: 4/5
6. Quiz—Decimals: 9/10
7. Homework Sept. 28: 5/5
8. Subtracting Decimals: 3/3
9. Using Data from Map: 7/8
10. Homework Oct. 1: 4/5
11. Quiz—Adding Decimals: 7/10

Total Possible Points: 58/66 87.9% = B

Parent's Signature ______________________

TO: ______________________ FROM: Mr. Smith

I am pleased to report that since our telephone conference, Jennifer's math achievement has improved, your support has made the difference. Jennifer has brought her failing grade up to a passing grade. With three more weeks in this grading period, I am hoping to see even more improvement.

Jennifer Jackson's scores as of 10/15/89

1. Homework Sept. 15: 3/5
2. Decimals page 36: 3/5
3. Adding Decimals page 40: 2/5
4. Estimating Decimals page 44: 0/5
5. Homework Sept. 25: 4/5
6. Quiz—Decimals: 8/10
7. Homework Sept. 28: 3/5
8. Subtracting Decimals: 3/3
9. Using Data from Map: 6/8
10. Homework Oct. 1: 4/5
11. Quiz—Adding Decimals: 7/10

Total Possible Points: 43/66 65.2% = D

TO: ______________________ FROM: Ms. Russell

Here is a progress report on your daughter's eighth grade math work for the last grading period. Although Mary Ann is currently passing, her grade has recently fallen from a C to a D, and she appears to be having difficulty with decimals. I have some suggestions for supplementary activities that you can do with Mary Ann at home to strengthen her decimal skills. Please call me at xxx-yyyy, so that we can discuss this matter.

Mary Ann Bourne's scores as of 10/15/89

1. Homework Sept. 15: 3/5
2. Decimals page 36: 3/5
3. Adding Decimals page 40: 2/5
4. Estimating Decimals page 44: 3/5
5. Homework Sept. 25: 3/5
6. Quiz—Decimals: 6/10
7. Homework Sept 28: 3/5
8. Subtracting Decimals: 2/3
9. Using Data from Map: 6/8
10. Homework Oct. 1: 3/5
11. Quiz—Adding Decimals: 6/10

Total Possible Point: 40/66 60.6% = D

Activity

Telephone Calls to Each Parent

Objective

To establish personal communication with parents to obtain their support and involvement in the educational process

Grade Level

Grades 6–9

Time

5 minutes per student once or twice per year, for a total of approximately thirteen hours (You can spread calls over several weeks at three to four hours per week.)

Materials

Positive comments about each student

Procedure

Set aside three one-hour periods in the evenings or on weekends to make a personal call to each parent. You might begin by saying, "Hello, this is Ms. Rey. I am your daughter's math teacher. May I have five minutes of your time to explain our math program?" Continue by explaining that working with the parent will make the difference for the child's math success.

Topics you may want to cover briefly include:

1. You are pleased to have their son or daughter in your math class.

2. You have a goal that their daughter or son grow one or more academic years in math.

3. Explain homework, testing procedures, and the need for students to set up a quiet place to study at a prescheduled time daily.

4. Explain grading procedures.

5. Explain standardized, criterion testing, or other student assessments that are done yearly in your school system.

6. Let parents know when you are available for conferences and how to make appointments.

7. Ask parents to make positive comments to their son or daughter about math. Particularly stress the need to be supportive and encouraging, but to let the student do his or her own work. Close by inviting parents into the classroom during a math lesson at a prescheduled time.

If parents ask for general information about helping their child, suggest some of the resources listed at the end of this section, such as the book *Family math* by Stenmark et al. You may also want to ask if parents notice that their son or daughter is having a problem with some specific math skill. If so, offer suggestions to help (see strategies in this section).

If you feel some parents may not like being called at home, you might want to send a note home announcing that you will be calling.

Variation

You may elect to call just the parents who missed open house.

Activity

Open House

Objective

To involve parents in their children's math education

Grade Level

Grades 6–9

Time

Variable

Materials

"Tips for Parents of Girls" handout on the following pages

Procedure

In addition to your usual presentation at the school's open house, give copies of the "Tips for Parents of Girls" sheets to the parents of girls. Encourage the parents of boys to take the sheets also.

Variations

1. Starting with these handouts, prepare others and mail them to parents throughout the school year. Or, use the information to create newsletter columns.

2. Rewrite many of the hints for parents of boys.

Handout

Tips for Parents of Girls

Building Positive Attitudes toward Mathematics

Girls respond more than boys to parents' expectations and aspirations for them—have high expectations for her.

Math can be a difficult subject, but it's no more difficult for girls than for boys—be sure you don't give the impression it is.

Get across the message that all students—both boys and girls—have to put in some practice to develop their math skills.

Let your daughter know you think she has the ability to learn math concepts and skills—never indicate that you feel she is incapable.

Encourage her to do well in math and to expend effort, praise her for her learning accomplishments, but not just for "trying."

To develop her confidence, make sure she practices math skills. Let her know that persistence is a big part of math success.

Recognize her abilities, and show her you have confidence in her. Take an active interest in her education.

Let her know that you believe math is just as important for girls as for boys.

Whenever possible, help her see how math can be used at home—for example, converting measures, dividing amounts in recipes, selecting investments, or deciding which items to purchase.

Communicate to her that girls can do anything and that she can have any career she chooses.

Fostering Sound Mathematics Learning Strategies

If your daughter becomes frustrated and feels she just can't do math, don't give in to her tears. Be calm and supportive, while encouraging her to work through the problem.

When she's experiencing difficulty, ask questions that focus on what she does know about the problem; don't give her the answer or tell her how to solve the problem.

Try to help set goals that focus on understanding math and learning to apply the concepts, not just on getting a particular grade or test score.

Encourage your daughter to be independent; help her feel good about taking intellectual risks. Let her know it's okay to fail and that we learn from our mistakes.

Help her practice estimating and then measuring or counting to check out her estimations; e.g., How wide is the TV screen? Which of two containers holds more? Which is farther—the grocery store or the movie theater?

Make sure that math practice at home has a problem-solving orientation. For example, "If you need to get to school by 8:15, and it takes 45 minutes to get ready and 25 minutes to get there, when do you need to get up?" Let her practice her math skills on all sorts of "around-the-house" problems.

Encourage her to use objects, or manipulatives, to reason out problems.

Encourage her to draw diagrams of math story problems. Drawing a picture often helps give meaning to the problem's words and helps the student "see" a solution.

Hobbies, Games, and Computers

If possible, provide a calculator and help your daughter explore its many and varied uses.

If possible, give your daughter access to a computer, and help her learn to use it.

Find software games that teach math concepts and are fun and interesting for girls. (Ask her math teacher for a list of possibilities.)

Encourage her to use tools, build things, and do other traditionally "masculine" activities that teach spatial relationships. Don't label activities and skills as being "for boys" or "for girls," but "for people."

Find books of math puzzles and games; use them to help her learn math concepts and practice skills in an intersting and pleasurable way.

Play games with her. For example, the game Master Mind can strengthen logical thinking and problem-solving skills. Jigsaw puzzles can help with shape recognition and memory.

Providing Role Models

Become a role model for your daughter. Show by your actions that you enjoy and are competent using mathematics. Avoid telling her you are "no good" at math, no matter how you actually estimate your own skills.

Whenever possible, both parents need to model diverse roles, so that their daughter will see males and females doing nontraditional activities, for example, father fixing dinner or taking care of the baby, mother repairing a broken appliance, balancing the checkbook, or mowing the lawn.

Use books and stories to introduce women in mathematics and science.

Discuss women's traditional and nontraditional roles as depicted on TV. Help your daughter learn that each person is unique and that she does not need to follow a traditional path in planning her future.

Provide magazines that show women in math-related careers.

Resources

Burns, M. 1982. *Math for smarty pants.* Boston: Little Brown.

This book contains a wide range of accessible activities presented in an entertaining format. It would be particularly useful for expanding upper elementary students' perceptions of mathematics.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. The purpose of the program is ultimately to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes sections with activities that increase girls' confidence in math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction.

Kreinberg, N., and Stenmark, J. 1984. "Debunking the girls-can't-do-math myth." *Family Learning* 1, no. 3: 94–95.

This one-page article could be used as a handout for parent conferences. Especially written for parents, the paper stresses the importance of math education for girls and gives specific suggestions on how parents can encourage their daughters to achieve in mathematics.

Scott-Jones, D., and Peebles-Wilkins, W. 1986. "Sex equity in parenting and parent education." *Theory into Practice* 25, no. 4: 235–42.

This article, from an issue of *Theory into Practice* devoted entirely to the topic of sex equity and education, is an excellent resource for information about parents' role in the process of sex-role stereotyping. It provides excellent background reading for teachers and counselors who will be working with parents to promote math for girls.

Skolnick, J.; Langbort, C.; and Day, L. 1982. *How to encourage girls in math and science: Strategies for parents and educators.* Palo Alto, CA: Dale Seymour Publications.

This excellent resource examines the effect of sex-role socialization on girls' math/science skills and confidence. It explains how attitudes, parenting and teaching practices, stereotypical play activities and books peer pressure, and career and family expectations cause girls to question their abilities in math and science, and thus hinder their development in these areas.

In addition to a summary of the socialization process, this book contains a variety of compensatory educational strategies and activities that may be used to encourage females in mathematics. These particularly focus on increasing math confidence, spatial visualization skills, and problem solving and are designed for primary through junior high school students. Both parents and educators can benefit from this book.

Smith, S., and Backman, C., eds. 1975. *Games and puzzles for elementary and middle school mathematics: Readings from the Arithmetic Teacher.* Reston, VA: National Council of Teachers of Mathematics.

This book contains more than 100 articles on the use of games and puzzles to capture students' interest and imagination.

Stenmark, J. K.; Thompson, V.; and Cossey, R. 1986. *Family math.* Berkeley: University of California, Lawrence Hall of Science.

If mathematics promotion is a goal of your teaching, *Family math* activities will help you introduce parents and children to ideas that improve their math skills and help them gain an appreciation for math. Topics are geared to the K–8 math curriculum. Hands-on mathematical experiences provide families opportunity to develop problem-solving skills by looking for patterns, drawing pictures, working backwards, working cooperatively with a partner, and eliminating possibilities. The mathematical concepts learned from *Family math* are spatial relationships (geometry), estimation, data interpretation (probability and statistics), and mathematical reasoning.

Working with School Counselors

Your school counselor can be a valuable ally to assist you in presenting information on math-related careers to students and in encouraging girls to continue math studies and consider math-related careers. However, counselors at the junior high level typically don't have access to your students on a regular basis. Often, they need to be invited into your classroom. Before doing that, it is important that you determine your school counselor's attitudes toward girls and mathematics. Many counselors hold stereotypical views about appropriate occupations for women and about females' math abilities. Out of "concern," many counselors steer girls away from math—believing it is "too difficult" or "not appropriate" for girls.

- Counselors provide boys more explicit rewards, encouragement, and reinforcement for learning mathematics and for considering math-related careers than they do for girls. In one study, counselors admitted they had discouraged girls from taking advanced math classes because of their own stereotypical attitudes toward women and math. (Stage et al. 1985)

- Counselors appear to have either a neutral or a negative effect on girls who want to pursue math-related careers. (Armstrong 1980)

- Several studies of women who pursued mathematics study and careers indicate that counselors often provided no encouragement—some even attempted to discourage the young women from pursing mathematical or scientific careers. Counselor encouragement was significantly related to advanced mathematics course enrollment of twelfth-grade boys, but not girls. (Fox 1981)

- Casserly found that many guidance counselors still believe that careers in mathematics are more appropriate for males. (Cited in Fox 1981)

The strategies on the following pages will give you some suggestions for ways you can both subtly educate and enlist the help of counselors in your efforts to increase all students' awareness of math usefulness and potential math-related careers.

Strategies

1. Establish a link with your school counselor; try to make her or him your ally in encouraging girls in math.

2. Talk with your school counselor about girls and math on an informal basis. Try to determine her or his attitudes. If you find your counselor holds stereotypical views on women and math, try to debunk these myths in a nonconfrontive way. Counselors often have not been exposed to a great deal of mathematics during their education. Let them know how important it is that girls feel confident about math, learn about its usefulness for them and their futures, and avoid stereotyping math as a "male" subject.

3. Provide your counselor with some good reading materials on girls and math. For example, the first three chapters of *How to encourage girls in math and science* by Skolnick et al. contain an excellent summary of the issues involved. Check the resource list at the end of this section for more suggested readings.

4. If your counselor does not already have some good information on math and careers, suggest some sources. Again, check the resource list in the career section of this guide. The two posters (*When are we ever gonna have to use this?* by Saunders and *Dropping math?* by Wiggan) and the brochures (*Why take more math* distributed by the Equal Employment and Affirmative Action Office, *You will need math, The math in high school you'll need for college,* and *Careers in mathematics* by the Mathematical Association of America) are excellent ways to provide counselors with information about the importance of mathematics.

5. Enlist your counselor's help in building a library containing math-related career information for students.

6. Ask the counselor to visit your class and present lessons on stereotyping or on math and careers. The resource list contains some excellent materials with suggested awareness activities. Also, you might ask your counselor to co-teach these lessons with you.

7. Enlist the counselor's support in identifying sites for math occupations-related field trips and/or positive female role models who could visit your classes to talk about their math-related careers.

8. Ask your counselor to help you involve parents in encouraging their daughters in math. Ask him or her to assist in developing activities for parents, writing a column about the importance of math for all students for your school newsletter, or speaking to parent groups.

9. Use a team approach with counselors, other teachers, and administrators. Talk with them in a nonthreatening way about how girls need math as much as boys do. Explain why counselors should (a) expect and insist on as much effort in math from girls as from boys and (b) track just as many girls as boys into advanced math classes.

10. Most of your junior high students will go to one or two particular high schools in your community. Ask one or more counselors from those schools to visit your math classes to inform students about the transition process, high school curricula, and the math options available. Make sure these counselors stress the need for four years of high school math.

11. Counselors can also be of assistance in helping you raise the consciousness of other math teachers in your school regarding equity issues. All teachers need to be aware of the messages they are giving to students—particularly those unintentionally destructive messages that it's okay for girls to fail at math.

12. If your school does not offer a career exploration course, ask your school counselors to organize one. Students need to be making the connection between school subjects and occupational choices, and an exploratory course can help them do this.

Resources

American Statistical Association. n.d. *Careers in statistics* and *Statistics as a career: Women at work.* Pamphlets. Washington, DC: American Statistical Association.

In these pamphlets, career opportunities in statistics are described, and statistics careers for women are highlighted.

Askew, J. 1982. *The sky's the limit in math-related careers.* Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

This interesting book describes contemporary women in highly math-related occupations. Each of the chapters—on computers, engineering, finance, math education, research mathematics, and statistics—includes several pictures and quotes from women about their jobs and the satisfaction they receive from them. Content is suitable for upper elementary, junior high, and high school students.

Campbell, P.B. 1986. "What's a nice girl like you doing in a math class?" *Phi Delta Kappan* 67, no. 7: 516–20.

This is an excellent summary article that describes sex differences in mathematics achievement and career choices, differential treatment and expectations, and effective programs for promoting equity in math education.

Casserly, P. L. 1983. "Encouraging young women to persist and achieve in mathematics." *Children Today* 12, no. 1: 8–12.

Casserly's article summarizes the factors that enhance or inhibit young females in their study of mathematics. Many strategies for classrooms, counselors, and parents are discussed.

Casualty Actuarial Society. n.d. *The actuarial profession.* Pamphlet. New York: Casualty Actuarial Society.

A pamphlet describing career opportunities for actuaries.

Equal Employment and Affirmative Action Office. 1987. *Why take more math?* Brochure. Seattle, WA: University of Washington.

This interesting brochure includes reasons for selecting math courses in high school and math requirements for various college majors. Although specifically written for the University of Washington, the information applies to most colleges.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. The purpose of the program is ultimately to help teachers to promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes sections with activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction.

Kenschaft, P. 1986. *Careers for women in mathematics.* Brochure. Wellesley, MA: Association for Women in Mathematics.

This brochure describes the types of careers available in mathematics and the amount of high school and college math required for them. It also discusses discrimination against women in mathematics-related careers, suggests strategies for dealing with such discrimination, and presents statistics on women in mathematics. Several other pamphlets and brochures on mathematical careers are referenced in this brochure.

Massialas, B. 1983. *Fair play: Developing self-concept and decision-making skills in the middle school: Decisions about mathematics* (*Student guide* and *Implementation handbook*). Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

Decisions about mathematics includes many real-life activities to interest middle school students and to promote math-related careers. Activities are organized around the topics of "math and money," "collecting and analyzing data," and "your future."

Mathematical Association of America. n.d. *Careers in mathematics.* Pamphlet. Washington, DC: Mathematical Association of America.

This pamphlet contains an extensive list of references pertaining to mathematics and mathematics-related employment. Although the pamphlet is slanted toward high school students, it presents information that should be made available to all junior high students.

Mathematical Association of America. n.d. *The math in high school you'll need for college.* Pamphlet. Washington, DC: Mathematical Association of America.

This interesting pamphlet includes information on the content of high school math courses and a list of college majors with the number of years of high school math needed for each. Although the pamphlet is slanted toward high school students, it presents information that should be made available to all junior high students.

Mathematical Association of America. n.d. *Professional opportunities in mathematics.* Pamphlet. Washington, DC: Mathematical Association of America.

Career opportunities in mathematics-related fields are described in this pamphlet, which includes information suitable for junior high students.

Mathematical Association of America. n.d. *You will need math.* Pamphlet. Washington, DC: Mathematical Association of America.

This pamphlet discusses the reasons that students will need math and lists the amount of high school and college math required for jobs in many different fields. Although the pamphlet is slanted toward high school students, it presents information that should be made available to all junior high students.

National Council of Teachers of Mathematics. n.d. *Mathematics teaching as a career.* Pamphlet. Reston, VA: National Council of Teachers of Mathematics.

This pamphlet describes career opportunities in mathematics education.

Sargent, A. G., ed. 1985. *Beyond sex roles.* 2d ed. St. Paul, MN: West.

Exercises and information in this book may be used by individual readers or groups to become aware of the sources, scope, and magnitude of female/male sex roles. The book contains an excellent discussion of the ways sex roles are learned and reinforced by society. The chapter by Russo on the sex-role socialization process provides particularly good background information.

Saunders, H. 1981. *When are we ever gonna have to use this?* Chart. Palo Alto, CA: Dale Seymour Publications.

If you want a quick answer for students' proverbial question "When are we ever gonna have to use this?", order this attractive wall poster. The chart gives students information on just which careers require knowledge of specific math concepts. The chart can also be useful for developing your own math-in-careers activities.

Scott-Jones, D., and Peebles-Wilkins, W. 1986. "Sex equity in parenting and parent education." *Theory into Practice* 25, no. 4: 235–42.

This article, from an issue of *Theory into Practice* devoted entirely to the topic of sex equity and education, is an excellent resource for information about parents' role in the process of sex-role stereotyping. It provides excellent background reading for teachers and counselors who will be working with parents to promote math for girls.

Society for Industrial and Applied Mathematics. n.d. *Careers in applied mathematics* and *Profiles in applied mathematics*. Pamphlets. Philadelphia, PA: Society for Industrial and Applied Mathematics.

In these pamphlets, career opportunities in applied mathematics are described and selected employers in the field are profiled.

Wiggan, L., ed. n.d. *Dropping math? Say goodbye to 82 jobs.* Chart. Canada: Toronto Board of Education, Mathematics Department.

A brightly colored 18" x 24" poster that displays, in graphic form, each level (in the Canadian school system) of mathematics required for 82 jobs. You can easily relate the Canadian levels to those in the United States. The poster is suitable for students in grades 5–12.

Working with Administrators and Other Teachers to Promote Math in Your School

A school administrator's views on the relative importance of mathematics for students can help or hinder you in promoting math as an interesting and worthwhile subject. Although reading is also an extremely important subject, the recent emphasis on reading across the curriculum has sometimes resulted in the deemphasis of mathematics. It is important that you work with your school administrators to give mathematics a "high profile" and to provide recognition for students who are high achievers or who have demonstrated strong gains in math achievement.

- Schools can affect mathematics course enrollment and achievement through availability of math courses and programs. (Chipman and Wilson 1985)

- Early identification of mathematically able students and academic tracking are among the most favorable school conditions for female students' later enrollment in advanced math classes. (Casserly, cited in Chipman and Wilson 1985)

- Girls in schools with accelerated science programs showed unexpected gains in math achievement. (Casserly, cited in Chipman and Wilson 1985)

Although academic tracking has been found to be a favorable condition for female students enrolled in advanced math classes, it is important to note that tracking may be detrimental for many students. Students are sometimes tracked into homogeneous "below average" or low-achievement groups based on their standardized test scores. In some school systems, this tracking becomes an almost permanent placement that restricts students from advancing to higher level math courses. Because they have not had the background in earlier years, these students find themselves unable to enter academic college prep math classes in high school. The ideal school situation is one in which each student is challenged at his/her own level of ability and each is allowed to reach her/his maximum achievement in all subjects.

The following strategies can be used to enlist administrator support, work with other teachers, provide personal recognition for math students, and generally promote mathematics in your school.

Strategies

1. Your principal can set the tone for promoting math in your school and can act as an advocate for teachers. Enlist your principal's support in promoting mathematics, especially for girls.

2. Make sure your principal understands how important computer literacy is to your students' futures. Lobby for a modern computer lab with up-to-date equipment and software.

3. Ask your principal to provide personal recognition to students who have made outstanding progress in math (see activities on the following pages).

4. Your principal may have developed excellent ties with people in business and industry. Enlist their aid in selecting and contacting outside speakers who can serve as role models for girls in math.

5. Some junior high math teachers need time to develop their math teaching skills, and all teachers need to keep up with the latest developments in their fields. Math teachers also need to belong to professional organizations and attend conferences on mathematics education. Urge your principal to make staff development activities in mathematics a priority for teaching in your school and to provide adequate release time for them.

6. For girls with high math ability, early identification, homogeneous grouping, and accelerated math programs have been found to be extremely positive factors in promoting later math study and careers. The earlier the acceleration is accomplished, the better, according to Casserly (1983). Enlist your principal in efforts to design an accelerated math program for those students who are unchallenged by the regular mixed-ability classroom.

7. As suggested with counselors, talk with other teachers and administrators in a nonthreatening way about girls and math. Try to help them understand the importance of teacher expectations and interaction patterns as well as math confidence building for girls. Make sure they're aware of how important math is for girls' futures, so that they don't "let them off the hook" when it comes to learning mathematics.

8. Form a math promotion team of teachers, counselors, and administrators in your school. Get together to brainstorm ideas on how you can build a positive school climate for mathematics and how you can provide recognition and rewards for students' accomplishments in mathematics.

9. Use your math team to monitor students' progress as they move from teacher to teacher or course to course through your school.

10. Help other teachers strengthen the math curriculum in your school by incorporating a problem-solving approach to math. Make sure other math teachers don't ignore teaching word problems and that they involve students in extended situational lessons and problem-solving experiences.

11. Ask one or more other teachers to participate with you in the exercises to assess teacher-student interaction patterns described in the "Learning Environment" section of this guide.

12. Suggest that other teachers also conduct stereotype awareness activities with your school counselor.

13. Enlist other teachers to help you carry out a research project to determine whether students in your school hold stereotypical views about appropriate careers and roles for women. The resource list following these strategies contains references with activities that will help you do this.

14. Work with other teachers to develop ways you can incorporate mathematics into other subjects; for example, using math-related activities in history class, assigning readings about women mathematicians, having students write about mathematics, using math in science projects, and so forth. These activities will help students see how mathematics relates to and can be used in almost every other school subject. Check the resource list for curriculum guides and programs that integrate math into science and language arts.

15. Combine math with other subjects by assigning math projects that require library research. Let students research and write papers on math-related careers. Work with the English teachers in your school to design and grade these dual assignments.

16. If other junior high teachers feel uncomfortable with math, help organize nonthreatening peer teacher sessions where they can practice and develop their own math skills in a supportive, nonjudgmental environment.

17. Help your school librarian build a collection of mathematics materials. This could include books about women and mathematics, integrating math across the curriculum, games and puzzles, and materials about math-related careers. Check the resource list for suggestions.

18. To recognize students' math accomplishments, select a schoolwide "Math Student of the Month." Ask teachers to submit the names of one or two students who have shown outstanding performance or improvement in math. Use a committee of three—an administrator, counselor, and teacher—to select the best of the candidates based on teacher recommendations. Take a photo of the student and place it on the school's main bulletin board. State that "Susan Kelly Is the Math Student of the Month." Issue certificates of merit to the winner and the runners-up.

19. Place a problem of the month on the bulletin board, and let students provide solutions. As much as possible, use problems that allow more than one solution. Encourage students to provide their problem-solving strategies with diagrams, etc.

20. Use school newsletters to provide information on outstanding math students, math club activities, math-related guest speakers, math field trips, MATHCOUNTS winners, and students who scored well on the American Junior High School math exam.

21. Inform the editors of your school district publications about math news or math club activities in your school.

22. At the end of the school year when students are recognized for accomplishments at awards assemblies, make sure that math is not forgotten.

Activity

Letters from the Principal

Objective

To involve adminstrators in the promotion of mathematics; to provide a special opportunity for parents to have their children recognized by educators in a simple, yet important manner

Grade Level

Grades 6–9

Time

30–60 minutes

Materials

Positive comments about students math performance

Procedure

Personal communications from the school to parents and students help promote a positive, caring image of our schools. Ask your principal to write letters (see examples on the following page) and personally give them to students who complete a given grading period with grades in the top five (or whatever number you select) of their math class. Often the principal does not have an opportunity to meet students and commend them for their success in mathematics. Students should take these letters home. Parents can also use this as an opportunity to encourage their children. These letters should be typed on the school's finest letterhead and copies placed in the students' files.

Variation

Ask your principal to write letters and personally give them to students who have improved significantly in your math class. This might include any student who was previously failing and who is now passing or one whose math grade has risen at least one grade point. These letters should be typed on the school's finest letterhead and copies placed in the students' files.

November 19, 19XX

Dear Ms. Roberts:

Tami's math teacher, Ms. Mason, tells me that Tami ranked in the top five of her math class for the first nine weeks grading period. I'm sure you must be as proud of Tami as we are. Ms. Mason joins me in congratulating Tami on this achievement, and we urge her to keep up the good work.

Sincerely,

John G. Brown, Ed.D.
Principal

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24 April 19XX

Dear Mr. and Mrs. Green:

Kathleen's math teacher, Ms. Smith, tells me that Kathleen has improved tremendously this year. Her attendance is a lot better, and her classwork and class participation have enabled her to raise her grades to As and Bs. She has been a real contributor to the class.

I join Ms. Smith in congratulating Kathleen and encouraging her to keep up the good work.

Sincerely,

Mary R. Lewis, Ed.D.
Principal

Activity

Principal-Student Conversations

Objective	To provide students with a feeling of accomplishment by having the principal personally acknowledge their math performance
Grade Level	Grades 6–9
Time	Variable
Materials	Positive comments about students math performance
Procedure	Ask your principal to talk to students who are performing on a praiseworthy level in your math class or are showing significant improvement. Ask your principal to encourage these students and to relate the importance of mathematics to success in life, especially for girls.

Resources

Casserly, P. L. 1983. "Encouraging young women to persist and achieve in mathematics." *Children Today* 12, no. 1: 8–12.

Casserly's article summarizes the factors that enhance or inhibit young females in their study of mathematics. Many strategies for classrooms, counselors, and parents are discussed.

Cheek, H. N., ed. 1984. *Handbook for conducting equity activities in mathematics education*. Reston, VA: National Council of Teachers of Mathematics.

In this handbook, problems of underrepresentation of females and minority group members are discussed, and several programs designed to promote equity are described. The book also includes a comprehensive list of publications, materials, and organizations that can serve as resources.

Howard, B. C. 1982. *Mathematics in content areas (MICA): A teacher training approach*. Washington, DC: Office of Education, Teacher Corps.

This resource details an agenda for an in-service program to develop elementary and secondary teachers' mathematical abilities and to help them integrate and teach mathematical concepts across the curriculum. In the secondary model, math teachers identify math skills most appropriate for supporting other subject areas; increase their abilities to provide instruction in at least one additional subject area through the use of mathematics; and develop skills in consultation, curriculum building, and team teaching. In the second phase of the program, a math teacher works with one or more content area teachers in peer support learning teams.

Wheeler, M. 1986. *Mathematics library—Elementary and junior high school*. Reston, VA: National Council of Teachers of Mathematics.

This is a useful purchasing guide for teachers and librarians. It contains an annotated bibliography of children's math books.

Wiebe, A., and Hillen, J., eds. 1986. *AIMS Newsletter*. Fresno, CA: AIMS Education Foundation.

This newsletter describes the AIMS (Activities That Integrate Math and Science) Program. The program includes a wide range of science and math activities and focuses on the integration of learning experiences, problem-solving activities, and cooperative learning for grades K–9.

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